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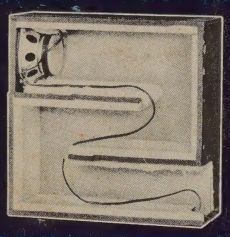

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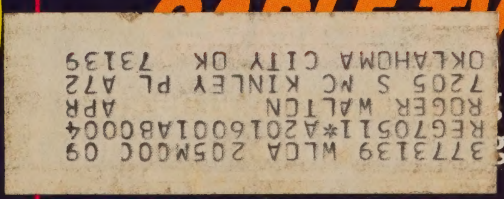

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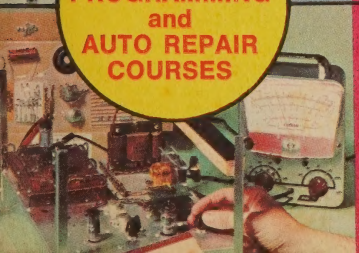

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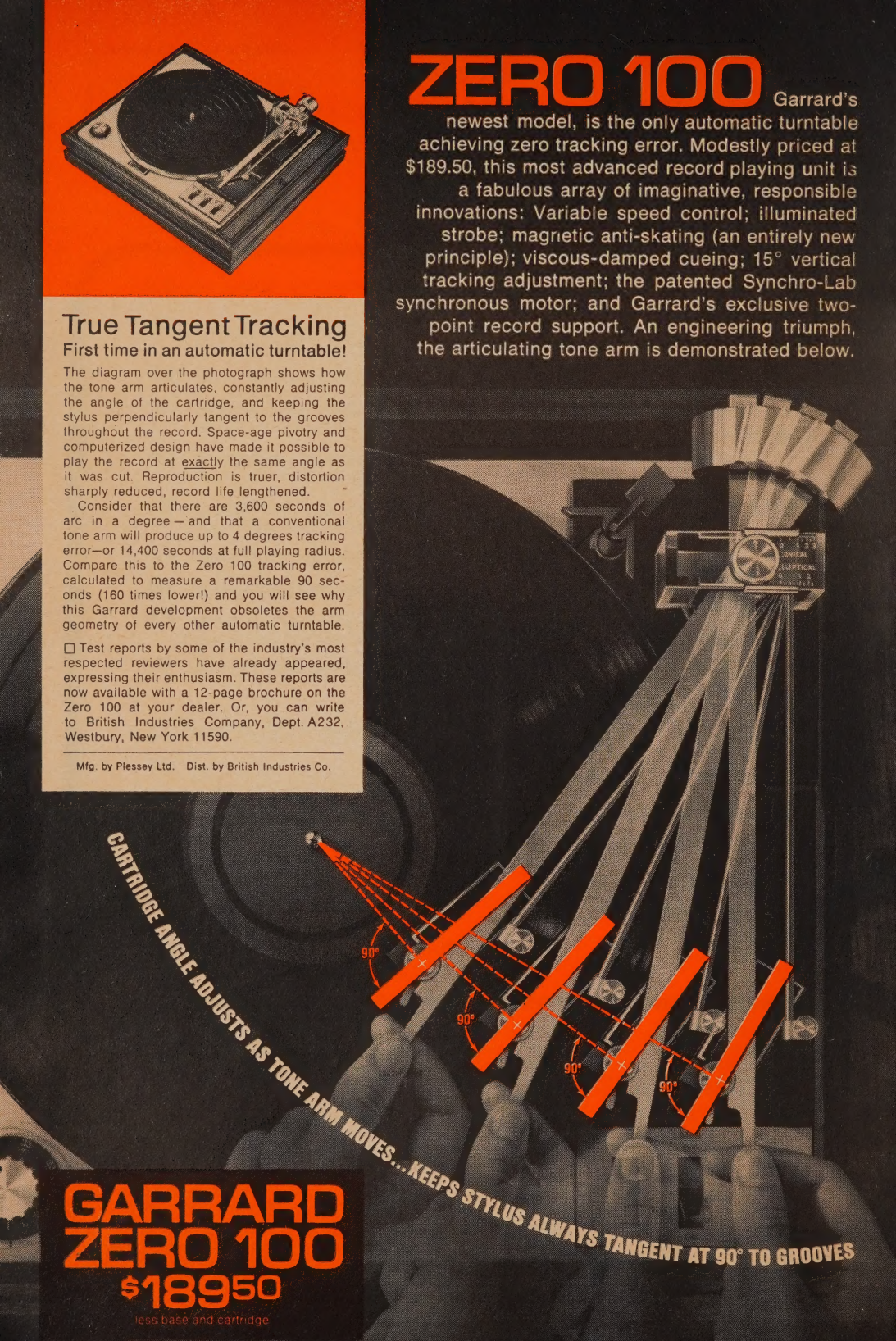

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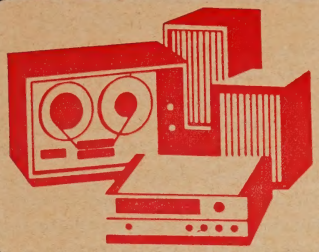


Stereo Scene

By J. Gordon Holt

HOW GOOD NEED A TURNTABLE BE?

BACK in the dark ages of audio, circa 1952, an equipment report on a then-new transcription turntable described it as having "inaudible" wow, flutter, and rumble. A comparison between the test results published in that report and the results of tests on some modern turntables reveals that the latest ones have about 1/10 as much speed variation and less than 1/20 as much rumble. All of this raises a question: If that 1952 turntable had inaudible speed variation and flutter, then what can possibly have been gained by reducing these things to fractionally smaller magnitudes? Doesn't that seem rather like overkill to the point of pointlessness? It may seem that way, but it isn't.

Objectively, there is no question that today's best turntables *are* markedly better than the best available 20 years ago. The problem, then, is the interpretation of that subjective word, "inaudible."

Like all other subjective observations, "inaudible" is relative. The audibility of things depends on the listener, the program material and the listening volume, and all of these things have become more demanding of turntable performance in the years since that early "inaudible" turntable.

Speed variation, for example, is most conspicuously evident when reproducing a sine wave of fixed frequency at around 3000 Hz. With that "program" source, even an untrained and rather uncritical ear can detect speed variations of as little as 0.2%, while a highly trained ear can pick up variations of as little as 0.05%. On musical material, speed variation becomes less audible, and its audibility depends on the *kind* of music. Percentages of wow and moderately slow flutter that are audible on sustained musical notes or chords may be completely undetectable in music with fast tempos or staccato notes. On harpsichord, slow piano, or the sustained notes of reedy woodwind instruments and some organ stops, a trained listener will be doing well to detect 0.5% of slow wow, but some kinds of rapidly recurring flutter are audible at 0.1% and annoying at 0.3%.

While we're on the subject of turntable wow, it might be worthwhile to digress for a moment to consider do-it-yourself testing in the home. Many audiophiles use test records (with a 3000-Hz tone) for checking speed variation in their own turntable, and while these tests *can* give meaningful indications, they often do not. If the test record is good, it is safe to assume that any audible speed fluctuation that occurs more than once per revolution of the turntable is due to a flaw or a malfunction in the turntable. Once-per-revolution wow, however, *can* be the fault of the turntable, but may not be. Binding in the platter's main bearing can cause this, but then so can eccentricity of the test record's grooves. And it takes but an exceedingly small amount of eccentricity to cause audible wow. This means that, not only must the test record be pressed with an extremely accurately centered spindle hole, it must also fit the platter spindle snugly enough to preclude the possibility of any play at all. The conditions for perfection here are just too stringent to depend on, so the best advice is: "If you can't hear *any* wow, your turntable is fine in this department, but if you can, it may still be fine."

Of even less value as a wow test is the visual observation of a turntable's stroboscope pattern. Strobe patterns are not normally as concentric as even a typical mass-produced disc, and their eccentricity has the same effect—a once-per-revolution

"wander" back and forth across their center speed. Many audiophiles have returned new turntables as "defective" because they assumed that the variations of the strobe indicated wow. It rarely does. Neither do the once-per-revolution "skips" of the strobe pattern—sudden shifts in the positions of the strobe bars. These too are due to nothing more than imperfections in the printing of the strobe pattern. So remember, a strobe is for determining *average* platter speed only. It cannot be used to judge anything else.

Advancing Rumble. If rumble is low enough to be inaudible, it doesn't matter how *much* below audibility it is. But several things have happened in audio to make yesterday's barely inaudible rumble intolerably audible today. Stereo was one of them.

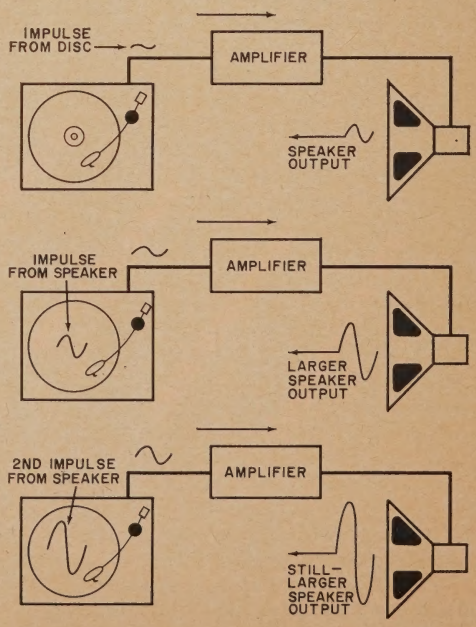
The stereo LP was unheard of in 1952. All discs were monophonic, and the groove modulations were side-to-side. The only vertical motions of the stylus were due to surface noise or "pinch effect" distortion, so all good pickups were designed to be insensitive to these vertical vibrations. For this reason, a turntable had to be free only from *lateral* vibration in order to be rumble-free. If the platter bearing made little grinding noises, what the heck? All they caused were vertical vibrations.

Then came the stereo disc, with its stereo difference signals inscribed as vertical groove modulations, and vertical platter irregularities became as audible as lateral ones. Even a turntable that had *equal* amounts of vertical and lateral vibration produced twice as much rumble when pickups went stereo, so the figures for acceptable rumble performance had to undergo a drastic downward revision.

Another thing that put the squeeze on rumble requirements was the continuing increase in the *volume* at which people listen to music. Subjective assessments of listening volume are largely influenced by the distortion content of the sound. Witness the little table radio, cranked up to the point of gross overload of its 5-watt amplifier, which sounds infinitely louder than 50 watts per channel of *clean* audio signal in the same room. Thus, as more *clean* audio power became available from amplifiers, audiophiles found themselves listening, without any sense of discomfort, at higher and higher levels. But since the modulation levels on discs have not increased substantially since the early 1950's, this meant running the system's volume control at increasingly higher settings. And of course, the turntable rumble came up with the music. Symphony and opera lovers now bathe in room-shuddering crescendos that would have been difficult to achieve a mere 10 years ago, while the combined forces of acid rock and the discotheque mania have pushed the listening-volume demands of some people to the point where no conventional hi-fi components can make the grade. Special rock-reproducing systems are now available for those people who have tired of blowing their 100-watt loudspeakers apart with 300-watt amplifiers.

Fortunately, the kind of rock music that is supposed to be played at that volume doesn't have much dynamic range, so the music never gets quiet enough to uncover turntable rumble. What *does* frequently become a problem, though, is acoustic feedback from the speakers to the phono unit. (This is why some loud-music

A pickup responds to any vibrations, even those not eminating from the disc itself. Thus, as shown above, sound vibrations from the speaker are fed back to the pickup and amplified—each feedback adding to the last and producing a serious rumble.



enthusiasts prefer tape to discs; it doesn't feed back. It hisses, though.) This can plague even the more moderate serious-music listener, and is a major factor in what some people believe to be excessive rumble from modern turntables. And it, too, is one of the prices we pay for better reproducing systems.

The low-frequency response of most loudspeakers goes deeper today than it did in earlier systems, and solid-state amplifiers can deliver more low-frequency power to them than did most tube-type amplifiers. These two factors alone could make 1952's "inaudible" rumble audible on a modern system, but in conjunction with the other rumble promoters, they can add up to disaster. Extended low-frequency response encourages acoustic feedback as much as does high-level listening. And the effect of this feedback can sound exactly like a bad case of rumble, even when the turntable is intrinsically extremely quiet.

A pickup responds to any vibration of its stylus, whether due to groove modulations or, in the case of acoustic feedback, to signal vibrations coming from the loudspeakers. In a feedback situation, a single loudspeaker vibration will cause a stylus vibration, which in turn produces another speaker vibration. If the second vibration from the speaker is weaker than the first, it will still be fed back as before, but at a reduced amplitude. Hence, there will be a *series* of vibrations, but they will gradually die out. This is known as a state of marginal or incipient feedback.

But if we turn the volume control up enough, each impulse coming from the speaker will be *louder* than the preceding one. The feedback signal will be stronger with each repetition, and the feedback will build in strength until it either drives the amplifier to complete overload or wipes out the speakers, the amplifier, or both. The feedback signal generally occurs at some low frequency, and there is no mistaking the rumbling crescendo of a really bad case of it. But incipient feedback is not that readily recognizable for what it is, because all it seems to do is exaggerate the system's bass response and, of course, its turntable rumble.

Testing for Feedback. There's an easy way of checking for incipient feedback. Shut off the phono motor, place the stylus in an outer disc groove, set the volume

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about where you normally use it, and gently tap the base of the tonearm with a fingertip. If it makes a sharp, tight, "thud" from the speakers, you can forget about feedback. If it makes a "boom," though, and turning down the volume then produces the requisite "thud," you've got incipient feedback, and chances are your turntable's rumble performance is a lot better than you suspect.

If you do have feedback, it's important to remember that this may *not* be reaching the pickup through the floor or walls of the room. Some combinations of turntables and arms are rather efficient detectors of airborne sound waves, and such units appear maddeningly perverse in that, the better you isolate them from the floor, the worse their feedback becomes. A simple test for this condition involves pressing gently downward on the turntable's suspension system until it bottoms, and noting whether the feedback tendency increases or decreases. If it decreases, the problem is airborne, and one solution is to add as much inertia as possible to the table's floating suspension. Sometimes, merely bolting this firmly to its base (thus eliminating the suspension altogether) will lick the problem. We'll consider alternate solutions in a future "Stereo Scene."

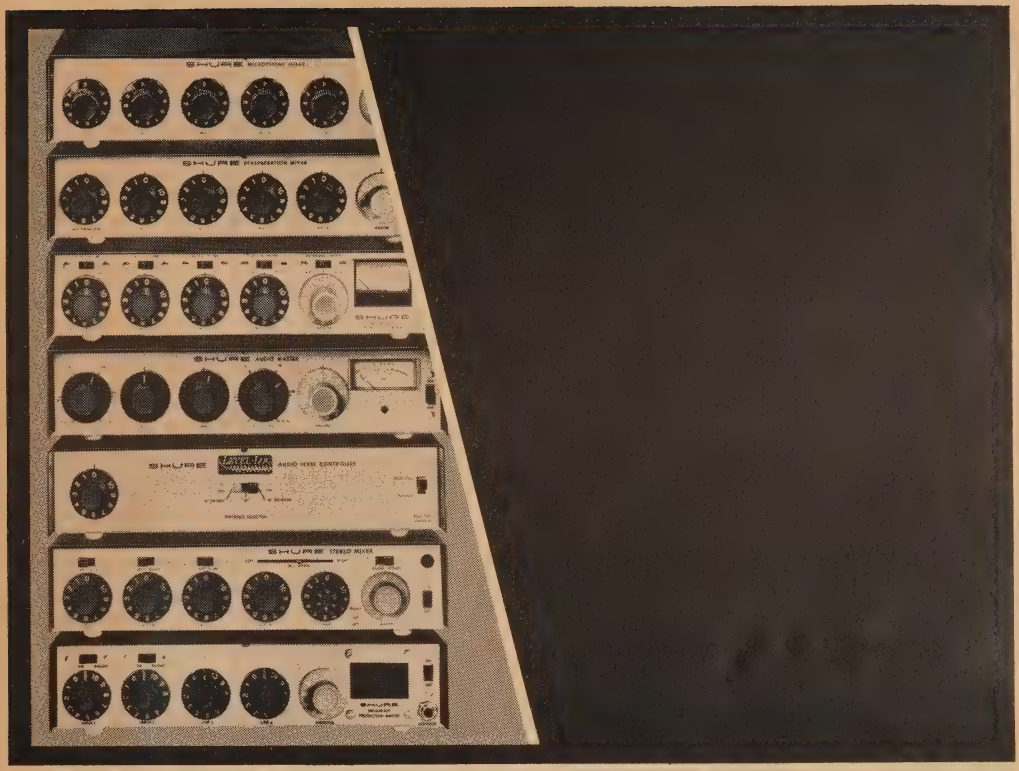
Feedback suppression is one of the strong points of a few of the latest, weirdest looking turntable designs, so even though their measured rumble may only be a few decibels below that of your present table, they may have subjectively much less rumble than you're now getting, merely because feedback isn't exaggerating it any more.

If your present turntable has audible speed variation, and is not actually defective, you can certainly benefit from the improved stability of a better model. But even if you are not currently bothered by wow or flutter, a unit with better than 0.05% speed regulation will nearly always provide a subtle but audible improvement in the solidity of the sound. Below that figure, the audible improvement is likely to be academic.

When shopping for a new turntable, bear in mind that it is ultimate performance that you are buying, not features. Considerations such as idler versus belt drive, hysteresis versus induction motor, and featherweight versus battleship design are important only insofar as they affect the performance specs. For instance, a hysteresis motor will frequently provide better speed accuracy, but an induction type will often yield lower flutter. On the other hand, an induction motor with a speed vernier allows for *exact* speed adjustment, but the speed may change slightly from the outside to the inside grooves. And either type of motor can flutter if its drive pulley isn't perfectly concentric.

So-called battleship construction, with a large drive motor and a massive platter serving as a brute-force flywheel, has long been accepted as the only way to insure consistently stable turntable performance, but it isn't. The first hi-fi turntables were built this way simply because they were originally designed for recording or broadcast use, where a turntable was required to maintain proper speed under relatively massive loads. (Broadcasters cue discs by locating the opening passage, backing up a bit, then holding the edge of the disc while the felt-surfaced turntable spins free underneath it. Releasing the disc gives a virtually instant, slur-free start.) For reproducing microgrooves with a featherweight pickup, much less platter power is needed.

A platter's flywheel action is needed to smooth out small amounts of flutter from the motor and from irregularities in the main platter bearing. Obviously, if the motor's moving part is heavy, it will take a heavy flywheel to filter out any motor flutter, and the heavier the flywheel, the more load on *its* bearing. And the more bearing load, the more likelihood of rumble. On the other hand, a light drive motor can be de-fluttered with a relatively light platter, which will have a lightly loaded main bearing and concomitant freedom from rumble from that source. Thus, the issue is not so much one of the mass of the turntable platter, but of its mass *relative to* the mass of the drive motor. There is no inherent advantage to either the battleship or the featherweight approach, when it comes simply to playing discs. Either should be considered on the basis of its performance alone, rather than upon a preconceived notion of inherent superiority. Of course, if your turntable is going to be dragging other things besides a pickup (a "Dust Bug," for instance), then a featherweight turntable may not be for you. But that's your choice. ◈



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ALTERNATE ROUTES TO FCC LICENSE

With respect to the first item in "Opportunity Awareness" of November, 1971, I think it is very clear that Heiserman was factually wrong and he didn't do his homework.

I am enclosing a copy of our current school catalog. Note the Warranty on page 15. Cleveland Institute of Electronics originated the warranty concept over 20 years ago. Most schools now have a similar program, but we feel we have much more solid experience and a better FCC program. This certainly negates the first part of Heiserman's reply.

To complete the negation of his material, I refer to pages 20 and 21 of the catalog. I have marked a few of the lesson outlines to show my point. Other lessons include material on solid-state logic and control circuits in support of the coverage of fundamentals (such as the lessons on Semiconductor Diodes, How to Work With Transistors, etc.) Even a cursory examination of this catalog would have led an objective person to the conclusion that CIE did provide the material the unknown writer asked for.

Finally, Heiserman gratuitously gave some information on college level programs. May I invite a casual study of pages 33-35 of the catalog for a college-level program that is as good as (or better than) any available by home study?

G. O. Allen, President
Cleveland Inst. of Electronics
Cleveland, Ohio

My November, 1971, installment of "Opportunity Awareness" lists three home study schools whose catalogs state their communications graduates can qualify for a First-Class Radiotelephone License with a Radar Endorsement. Several other schools also offer courses that can lead to an FCC license with a radar tag. These are:

Cleveland Institute of Electronics
1176 East 17th Street
Cleveland, OH 44114

DeVry Institute of Technology
4141 West Belmont Avenue
Chicago, IL 60641

Grantham School of Engineering
1505 N. Western Ave.
Hollywood, CA 90027

International Correspondence Schools
Scranton, PA 18515

RCA Institutes
320 West 31 St.
New York, NY 10001

About a dozen other good home study schools offer courses that partly fulfill the educational needs of people wishing to get an FCC license with radar endorsement.

Once you've selected several schools that offer the courses you need, write each of them a personal letter specifying what you want to learn and requesting a complete outline of their courses. The same "Opportunity Awareness" article cited above, by the way, also suggests you request an appointment with a school representative. Although some home study schools, such as Cleveland Institute of Electronics can arrange a personal interview, two of the ones listed originally do not. (National Radio Institute and National Technical Schools)

DAVID HEISERMAN
Columbus, Ohio

A TV STATION IN SPACE

The October issue of ELECTRONICS WORLD contained the article "Interstellar Communications—What Are the Prospects?" It reported on the reception in London of an American TV station (KLEE-TV) after a 3-year delay, possibly as the result of what some postulated as "plasma cloud" or perhaps due to an interstellar transponder. The following letter (though we don't have the space to print all of the technical details) should be of interest to readers.

I never expected to see any further reference to the reception of KLEE in England after a supposed 3-year delay. It was a good prank while it lasted.

In 1958, I was the International DX Editor of the American Ionospheric Propagation Assoc., which was the only American club devoted solely to the observation and reporting of TV-DX. The group is still active today as the Worldwide TV-FM DX Association, Box 5001, Milwaukee WI 53204.

As International Editor, I corresponded with many TV-DX'ers all over the world. The strange reception of KLEE was frequently mentioned. Therefore, I did a detailed study of the characteristics required by the "plasma cloud." . . . If this cloud is merely a distant reflector, it must have a perfect parabolic shape with an error no more than 300 meters. It must also be astronomically large in order to collect enough energy to return a signal at 1.5 light-years distance. . . . The picture was transmitted (sup-

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Price $269, walnut enclosure — $33

Ask your dealer also about Crown's new companion **D150** power amplifier, which delivers 150 watts RMS guaranteed at 8 ohms (typically 100 watts per channel). No amp in this power range — however expensive — has better frequency response or lower hum, noise or distortion. It offers performance equal to the famous **DC300**, but at medium power and price. It's worth listening into!

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With the four-channel record a reality (whatever recording technique might become the standard), one thing is certain. Demands on tonearm and turntable performance are more exacting than ever. Thus, Dual precision is no longer a luxury, but a necessity.

If you would like to know what several independent labs say about Dual precision, write for complete reprints of their reports.

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CIRCLE NO. 40 ON READER SERVICE CARD

posedly) by KLEE at 55.25 MHz AM with negative modulation; audio at 59.75 MHz FM; picture at 525 lines by 30 frames. . . . The picture (and sound, by some reports) was received on England's channel 2 with video at 51.75 MHz AM with positive modulation; audio AM at 48.25 MHz; picture 405 lines by 25 frames. . . . Note that US negative modulation means increased transmitter power causes the picture to get blacker, while British positive modulation will get whiter with increased power.

After I published such an impossible set of conditions even to the fiction writer, a Swedish friend stated that he was in receipt of a letter from a British experimenter who admitted transmitting the KLEE test pattern but was afraid of legal action if he was ever known by name, and hence was not able to tell the truth about the hoax!

As for all the other better-documented cases of long delays (in the seconds), they are all easily explained on the basis of round-the-world signals which are trapped in the ionosphere for a number of revolutions. Only very rare conditions in the ionosphere would support such multiple hops, and with today's high noise levels and cluttered spectrum, it is no wonder it is not accidentally noted.

GORDON E. SIMKIN, W6KUH
Auburn Calif.

PC BOARD NEGATIVES

My own biased opinion is that any good circuit deserves a printed circuit board; but then making a board successfully by the resist-etch method can be tedious and is often fraught with perils—many a board has come out of the etch with a distinctly moth-eaten look! One obvious solution to the problem is the photo-processed board.

We can supply your readers plate-ready negatives of the printed circuit projects appearing in your magazine. We could provide up to a 6" x 6" final negative from copy that is 14" x 17" or smaller, for $2.50 each, postpaid. Overnight service would be the rule, and each negative would receive careful scrutiny for pinholes, hair-line cracks, etc.

ELRIC W. SAASKI
Art Unlimited
411 Abbot St.,
Richland, WA 99352

HELP WHERE IT'S NEEDED

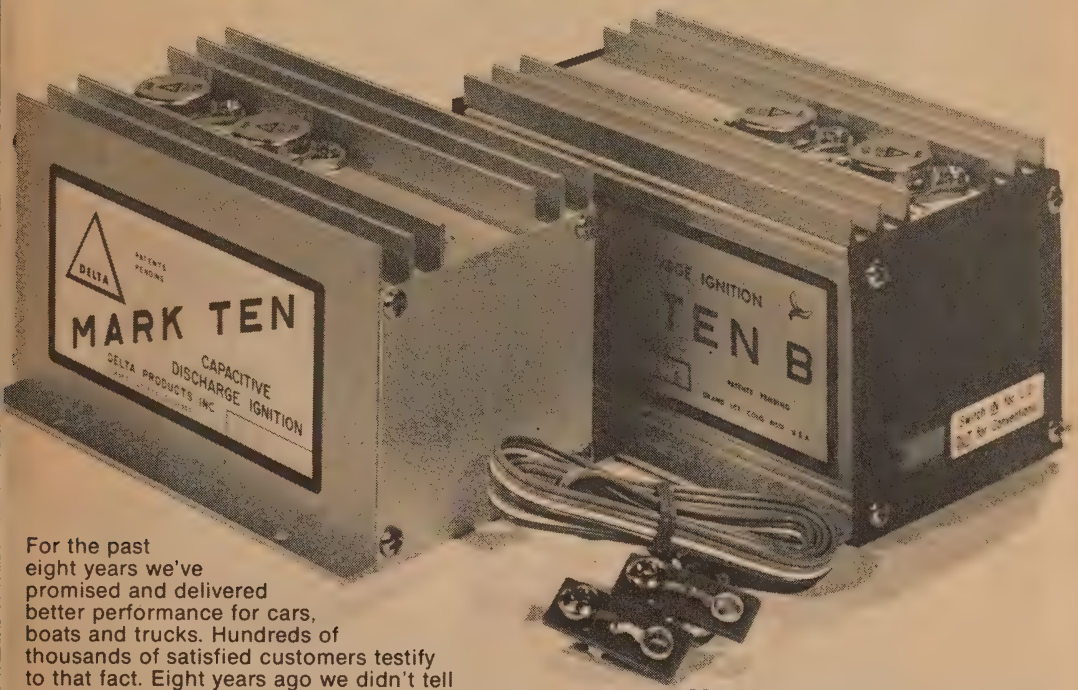
Regarding your editorial in the October 1971 issue ("A Typical Technician"), I think you would be amazed at how many handicapped people there are in electronics. If some of us tell how it was done, some others can possibly benefit!

Thank you for the uplift you gave just by printing Mr. Lizza's story.

M. J. ROTHERA
Los Alamitos, Calif.

CIRCLE NO. 11 ON READER SERVICE CARD→

Delta, pioneers of Capacitive Discharge Ignition systems, now offers two great CDI units to give your car better performance while reducing environmental pollution.



For the past eight years we've promised and delivered better performance for cars, boats and trucks. Hundreds of thousands of satisfied customers testify to that fact. Eight years ago we didn't tell you how the Mark Ten helps reduce environmental pollution, even though we knew this was an inherent advantage of the CDI system, because eight years ago no one was particularly interested in envjronment and how to save the earth from pollution. Today we all care and each of us wants to help prevent pollution. Here's how the Mark Ten and Mark Ten B CDI systems can help you do your share. It's simple and effective. **The more complete the combustion in your car engine the greater the reduction of residuals and other contaminants that create smog conditions. The Mark Ten and the new Mark Ten B provide energy many times that of conventional ignition systems, assuring a more complete combustion process.** Even Detroit has finally become aware many advantages of the CDI system. General Motors and Chrysler are installing them in new cars.

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Editorial

By Milton S. Snitzer, Editor

POPULAR ELECTRONICS—INCLUDING ELECTRONICS WORLD

A warm welcome to readers of ELECTRONICS WORLD who are joining us this month. We trust you will find much of interest in our pages and that you will like this new combined publication.

In October 1954, the first issue of POPULAR ELECTRONICS was born out of the pages of RADIO & TV NEWS—later to be called ELECTRONICS WORLD. It was felt that there was a need for a publication that would speak simply to beginners in electronics, new hobbyists, and novices. Projects were designed for those with a minimum knowledge of electronics and for the beginning ham.

However, the field of electronics has not stood still in the last 17 years. Along with its increased sophistication have come more knowledgeable hobbyists and experimenters, many of whom are in electronics professionally. Hence, the construction projects in PE have increased in complexity and in technical level.

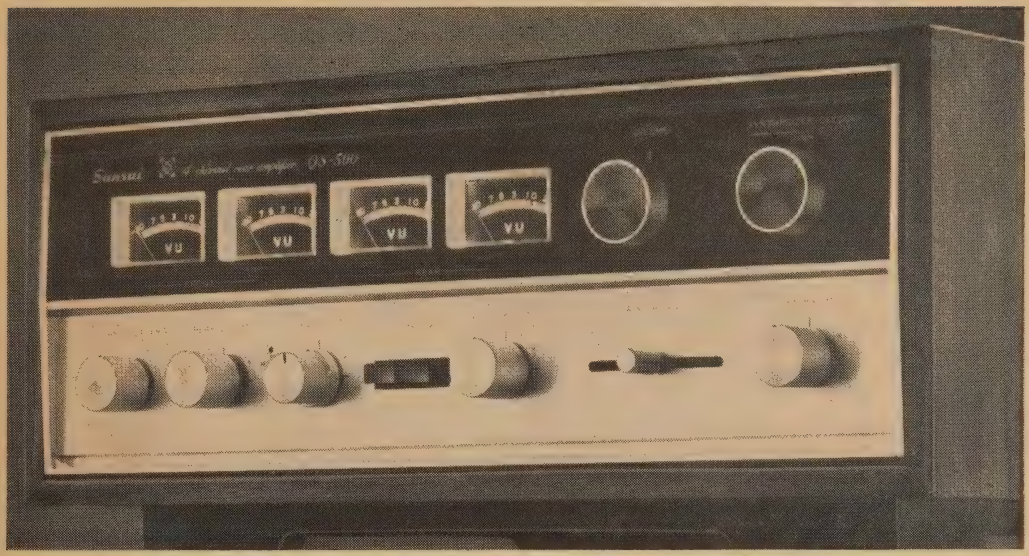
ELECTRONICS WORLD has also moved along with the changing field as its various name changes have indicated—all the way from its start as RADIO AMATEUR NEWS, to RADIO NEWS, to RADIO & TV NEWS, and finally to ELECTRONICS WORLD in 1959. It maintained its identity by catering more to the professional man in electronics, than to the hobbyist and experimenter.

As time went on, however, it became more and more difficult to preserve the separate identity of the two publications. Their technical levels got to be more and more the same; and, in a number of cases, both were read by the same people.

It seems only natural then that we include in the pages of POPULAR ELECTRONICS some of the same editorial coverage that was provided readers of ELECTRONICS WORLD; and that is what the new combined publication will do. It will satisfy those who are interested in building their own projects as well as those who like more general, tutorial, state-of-the-art, and product-oriented stories, and articles on new developments in electronics. At the same time we want to give our readers more information on what is going on in the general areas of audio and stereo equipment, communications, test equipment, and product testing and evaluation. To do this, we are adding a number of new columns on these subjects as well as incorporating some well-read columns from our sister publication. Of course, we will need more pages for this added coverage and that's what you will be getting.

We feel we are moving in the right direction instead of trying somewhat arbitrarily to maintain an artificial difference that really does not exist. To do the job we are using editors from both publications as you can see from our masthead. We hope our efforts will please both our new and old readers and that you will find the new POPULAR ELECTRONICS Including ELECTRONICS WORLD even more to your liking than the old.

if you go for four channel...



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You can decode any compatibly matrixed four-channel broadcasts or recordings and reproduce them in four authentic channels. You can detect the ambient signals present in most two-channel recordings or broadcasts and propagate them through the rear channels. In Sansui matrixing, the exclusive phase-shift technique prevents the cancellation of some signals and the change in location of others that occur in many matrixing systems. And the exclusive phase modulators restore the effect of the live sound field.

You can plug in a four-channel reel-to-reel or cartridge deck or any other discrete source. In the future — if you should have to — you can add any adaptor, decoder or what-have-you for any four-channel system for disc or broadcast that anyone's even hinted at. And a full complement of streamlined controls lets you select any function or make any adjustment quickly and positively.

The QS500 features three balance controls for front-rear and left-right, separate positions for decoding and synthesizing, two-channel and four-channel tape monitors, electrical rotation of speaker output, alternate-pair speaker selection, and four VU meters. Total IHF power for the rear speakers is 120 watts (continuous power per channel is 40 watts at 4 ohms, 33 watts at 8 ohms), with TH or IM distortion below 0.5% over a power bandwidth of 20 to 40,000 Hz. In its own walnut cabinet, the QS500 sells for $279.95.

An alternate four-channel miracle-maker is the modest but well-endowed QS100, with total IHF music power of 50 watts (continuous power per channel of 18 watts at 4 ohms and 15 watts at 8 ohms). In a walnut cabinet, it sells for $209.95.

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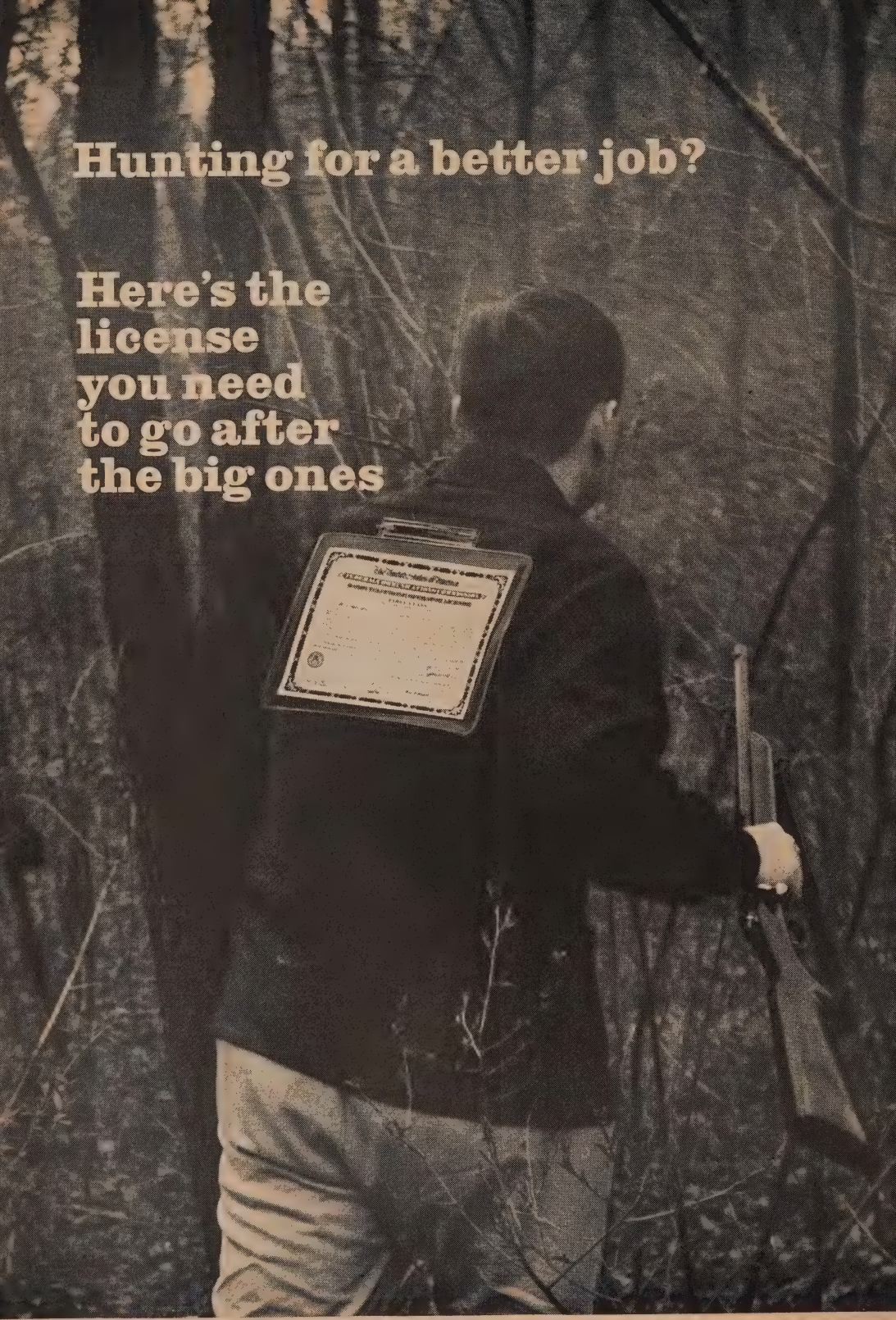

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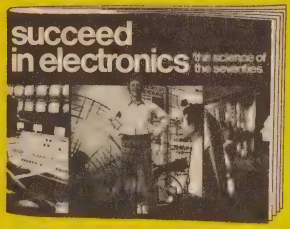

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But you *do* need knowledge, knowledge of electronics fundamentals. And there is only one nationally accepted method of measuring this knowledge... the licensing program of the FCC (Federal Communications Commission).

Why a license is important

An FCC License is a legal requirement if you want to become a Broadcast Engineer, or get into servicing any other kind of transmitting equipment—two-way mobile radios, microwave relay links, radar, etc. And even when it's not legally required, a license proves to the world that you understand the principles involved in *any* electronic device. Thus, an FCC "ticket" can open the doors to thousands of exciting, high-paying jobs in communications, radio and broadcasting, the aerospace program, industrial automation, and many other areas.

So why doesn't everyone who wants a good job in Electronics get an FCC License and start cleaning up?

The answer: it's not that simple. The government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. And that is to take one of the FCC home study courses offered by Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of 10 CIE graduates who take the exam pass it. That's why we can back our courses with this iron-clad Warranty: Upon completing one of our FCC courses, you must be able to pass the FCC exam and get your license—or you'll get your money back!

They got their licenses and went on to better jobs

The value of CIE training has been demonstrated time and again by the achievements of our thousands of successful students and graduates.

Ed Dulaney, Scottsbluff, Nebraska, for example, passed his 1st Class FCC License exam soon after completing his CIE training... and today is the proud owner of his own mobile radio sales and service business. "Now I manufacture my own two-way equipment," he writes, "with dealers who sell it in seven different states, and have seven full-time employees on my payroll."

Daniel J. Smithwick started his CIE training while in the service, and passed his 2nd Class exam soon after his discharge. Four months later, he reports, "I was promoted to manager of Bell Telephone at La Moure, N.D. This was a very fast promotion and a great deal of the credit goes to CIE."

Eugene Frost, Columbus, Ohio, was stuck in low-paying TV repair work before enrolling with CIE and earning his FCC License. Today, he's an inspector of major electronics systems for North American Aviation. "I'm working 8 hours a week less," says Mr. Frost, "and earning $228 a month more."

Send for FREE book

If you'd like to succeed like these men, send for our FREE 24-page book "How To Get A Commercial FCC License." It tells you all about the FCC License ...requirements for getting one... types of licenses available... how the exams are organized and what kinds of questions are asked... where and when the exams are held, and more.

With it you will also receive a second FREE book, "How To Succeed In Electronics," To get both books without cost or obligation, just mail the attached postpaid card. Or, if the card is missing, just mail the coupon below.

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News Highlights

Engineering Grads are Older

Statistics released recently by the Engineering Manpower Commission of Engineers Joint Council on engineering graduates reveal that grads are getting older. Data representing 270,000 graduates confirm the ages of 22, 24, and 27 as the most common ages for obtaining bachelor's, master's, and doctorate degrees. But the statistics show that only 36% of the bachelor's degrees were received at or before age 22, only 22% of the master's degrees by age 24, and only 28% of the doctorates by age 27. The reason for these figures is that many engineers pursue their education while engaged in cooperative work-study programs, or at night while holding down jobs. Others do not return to school for graduate study until they have spent several years in industry or in the military.

Closed-Circuit TV System for Hotel-Room Movies

Current motion pictures which have completed their initial theater showings and live sporting events, as well as other entertainment programming, are being shown in hotel rooms via closed-circuit TV. Trans-World Productions, the CCTV division of Columbia Pictures, unveiled the system at Atlanta's Regency-Hyatt House. As of this writing, it is planned that two major motion pictures will be telecast into the 1000 rooms of the hotel. The movies will be telecast through the existing hotel master antenna system without disturbing the standard television broadcasts. This eliminates the need for individual set wiring. A fee will be added to the patron's hotel bill.

Computers at the Races

The New York Racing Association is using Honeywell computers to help keep it in the winner's circle. Linked through an electronic network to all ticket-issuing machines and tote display boards, the computers update and post—every 90 seconds—the odds and dollars wagered on each horse. Payoffs are calculated and posted simultaneously with the official results of each race. Four computer systems process an average of $3 million in bets each racing day at NYRA's three tracks: Aqueduct, Belmont and Saratoga. Two of the computers operate in parallel as bets are being placed before each race. A third computer is on standby duty, ready to be switched into the system in case of equipment failure. The fourth computer is set up at the site of the next scheduled race meeting.

CB Club Members Indicted by Federal Grand Jury

According to reports received from Des Moines, we have learned that 22 members of a CB radio club have been indicted by a federal grand jury and have been accused of making it impossible for legitimate users of CB to transmit their messages. Club members were accused of 121 separate FCC violations including: use of call-sign names rather than proper FCC call signs, use of excessively high antennas, communicating with unlicensed stations and with stations over 150 miles away, and using more than 5 watts of power. Individual

charges in the indictment carry penalties ranging from a fine of $500 to $10,000 and two years in prison, upon conviction. Each person named in the indictment has been charged with from 5 to 15 counts each. The local U.S. Attorney said that this was the first time a grand jury anywhere in the nation had indicted CB radio operators for alleged abuses of FCC regulations.

Garrard Wins Berliner Award

Congratulations are in order to Garrard Engineering Ltd. for having won the 1971 "Maker of the Microphone Award" for its development of a zero tracking error tonearm. The award was established in memory of Emile Berliner, pioneer in the development of the microphone, disc record and phonograph, and is awarded annually for an outstanding contribution to the world of sound. The 1971 presentation marks the first time that the award has been bestowed on a commercial product.

Universal 4-Channel Decoder Announced by Electro-Voice

New 4-channel matrix decoding equipment that will decode all presently used or proposed matrixing systems, including CBS SQ, without need for switching by the listener, has been announced by Electro-Voice. Both complete decoder units for the consumer and IC chips for use by set manufacturers are being made available. The company has also unveiled a gain-sensing 4-channel reproduction system developed with matrixing pioneer Peter Scheiber. The circuitry further increases separation between channels and will be made available in more sophisticated hi-fi equipment later this year.

Ultrasonic TV Camera for Internal Body Organs

An ultrasonic camera system for viewing internal body organs is being developed and evaluated at Stanford Research Institute. The $244,000 program is funded under a grant from the National Institutes of Health. The new system, unlike ultrasonic systems now in diagnostic use, will produce focused television images of soft tissue structures in many organs. Thus, they can be used to view many organs that either are not visible to X-rays or that can be made visible only by injecting contrast media. The high sensitivity and high resolution of the ultrasonic camera, with its relatively short examination time requirement, should make it useful in mass screening.

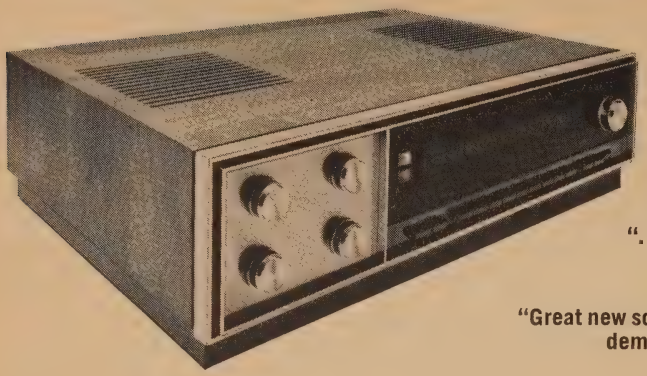
Inventor of Pulse Code Modulator Dies

Alec Harley Reeves, who is credited with the development of pulse code modulations, died recently of cancer at the age of 69. Dr. Reeves invented PCM in 1938 for transmitting telephone conversations or other electronic messages and data. Born in England, he spent his entire career with the International Telephone and Telegraph Corp. Until late in 1970, he was in charge of circuit research at the company's Standard Telecommunication Laboratories in Harlow, England. Dr. Reeves also helped to develop the first single-sideband radio system and the Oboe radio navigation system.

General Electric Closes Down IC Department

GE has announced that it was terminating the operation of its Integrated Circuit Products Department. The decision to close down the operation was made "because the potential financial returns of this business are not commensurate with the extremely large investment needed to become a significant manufacturer of integrated circuits." It was stressed that other departments within the Electronic Components Div. will not be affected.

New Heathkit AR-1500 stereo receiver



...the critics say it all:

"The AR-1500 is the most powerful and sensitive receiver we have ever measured..."
—JULIAN HIRSCH, *Stereo Review*

"...a stereo receiver easily worth twice the cost (or perhaps even more)..."
—*Audio Magazine*

"Great new solid-state stereo receiver kit matches the demands of the most golden of golden ears."
—*Radio Electronics*

Mr. Hirsch goes on to say: "The FM tuner section of the AR-1500 was outstandingly sensitive. We measured the IHF sensitivity at 1.4 microvolts, and the limiting curve was the steepest we have ever measured ...The FM frequency response was literally perfectly flat from 30 to 15,000 Hz. ...Image rejection was over 100 dB (our measurement limit)...

"The AM tuner was a pleasant surprise...It sounded very much like the FM tuner, with distinct sibilants and a quiet background, and was easily the best-sounding AM tuner we have had the pleasure of using...

"...all input levels can be matched and set for the most effective use of the loudness compensation. This valuable feature is rarely found on high fidelity receivers and amplifiers...

"The phono equalization was perfectly accurate (within our measuring tolerance)...The magnetic phono-input sensitivity was adjustable from 0.62 millivolt to about 4.5 millivolts, with a noise level of —66 dB, which is very low...When properly set up, it would be impossible to overload the phono inputs of the AR-1500 with any magnetic cartridge...

"...it significantly bettered Heath's conservative specifications. Into 8-ohm loads, with both channels driven, the continuous power at clipping level was 81.5 watts per channel. Into 4 ohms it was 133 watts per channel, and even with 16-ohm loads the receiver delivered 46.5 watts per channel. Needless to say, the AR-1500 can drive any speaker we know of and with power to spare...

"At 1,000 Hz, harmonic distortion was well under 0.05 per cent from 1 to 75 watts per channel...The IM distortion was under 0.05 per cent at a level of a couple of watts or less, and gradually increased from 0.09 per cent at 10 watts to 0.16 per cent at 75 watts...The heavy power transformer is evidence that there was no skimping in the power supply of the AR-1500, and its performance at the low-frequency extremes clearly sets it apart from most receivers...

"Virtually all the circuit boards plug into sockets, which are hinged so that boards can be swung out for testing or servicing without shutting off the receiver. An 'extender' cable permits any part of the receiver to be operated 'in the clear' — even the entire power-transistor and heat-sink assembly! The 245-page manual has extensive tests charts that show all voltage and resistance measurements in key circuits as they should appear on the receiver's built-in test meter...

"With their well-known thoroughness, Heath has left little to the builder's imagination, and has assumed no electronic training or knowledge on his part. The separate packaging of all parts for each circuit board subassembly is a major boon...

"In sound quality and ease of operation, and in overall suitability for its intended use, one could not expect more from any high-fidelity component."

From the pages of *Audio Magazine:* "...the AR-1500 outperforms the near-perfect AR-15 in almost every important specification...

"The FM front end features six tuned circuits and utilizes three FETs, while the AM RF section has two dual-gate MOSFETs (for RF and mixer stages) and an FET oscillator stage. The AM IF section features a 12-pole LC filter and a broad band detector. The FM IF section is worthy of special comment. Three IC stages are used and there are two 5-pole LC filters...

"...IHF FM sensitivity...turned out to be 1.5 uV as opposed to the 1.8 uV claimed. Furthermore, it was identical at 90 MHz and 106 MHz (the IHF spec requires a statement only for IHF sensitivity at 98 MHz but we always measure this important spec at three points on the dial). Notice that at just over 2 microvolts of input signal S/N has already reached 50 dB. Ultimate S/N measured was 66 dB and consisted of small hum components rather than any residual noise. THD in Mono measured 0.25%, exactly twice as good as claimed! Stereo THD was identical, at 0.25% which is quite a feat...

"...the separation of the multiplex section of the AR-1500 reaches about 45 dB at mid-band and is still 32 dB at 50 Hz and 25 dB at 10 kHz (Can your phono cartridge do as well?)...

"The real surprise came when we spent some time listening to AM... This new AM design is superb. We still have one classical music station that has some simultaneous broadcasting on its AM and FM outlets and that gave us a good opportunity to A-B between the AM and FM performance of the AR-1500. There was some high-frequency roll-off to be sure, but BOTH signals were virtually noise-free and we were hard pressed to detect more THD from the AM than from the FM equivalent. Given AM circuits like this (and a bit of care on the part of broadcasters), AM may not be as dead as FM advocates would have us believe!...

"As for the amplifiers and preamplifier sections, we just couldn't hear them — and that's a commendation. All we heard was program material (plus some speaker coloration, regrettably) unencumbered by audible distortion, noise, hum or any other of the multitude of afflictions which beset some high fidelity stereo installations.

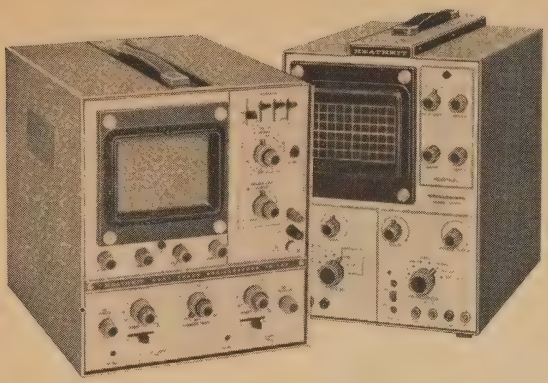
"Rated distortion [0.24%] is reached at a [continuous] power output of 77.5 watts per channel with 8 ohm loads (both channels driven). At rated output (60 watts per channel) THD was a mere 0.1% and at lower power levels there was never a tendency for the THD to 'creep up' again, which indicates the virtually complete absence of any 'crossover distortion' components. No so-called 'transistor sound' from this receiver, you can be sure. We tried to measure IM distortion but kept getting readings of 0.05% no matter what we did. Since that happens to be the 'limit' of our test equipment and since the rated IM stated by Heath is 'less than 0.1% at all power levels up to rated power output' there isn't much more we can say except that, again, the unit is better than the specification — we just don't know how much better...

"As always, construction instructions are lucid enough for the inexperienced kit-builder and there is enough technical and theoretical information to satisfy even the most knowledgeable audio/RF engineer."

Kit AR-1500, less cabinet, 53 lbs. **349.95***
ARA-1500-1, walnut cabinet, 8 lbs. **24.95***

and two precedent-setting oscilloscopes

New Heathkit dual trace DC-15 MHz solid-state scope sets a low-price precedent in high performance



Heathkit 5" IO-102 brings you solid-state scope performance on a budget

The new Heathkit IO-105 brings you a high performance scope designed for a wide range of measurements in instrumentation courses, engineering, R&D and electronics...at a fraction of the cost of comparable scopes. The big 5" (8x10 cm flatface) CRT provides separate signal display in channel 1 or channel 2 modes, direct comparison display in alternate and chopped modes, x-y mode for presentation of signals as a function of each other. Has triggered time base with 18 calibrated rates, 0.2 us/cm — 100 ms/cm in 1,2,5 sequence, ±3%; x5 sweep magnification. Compare the price, compare the specs... then order your IO-105 today.

Kit IO-105, 40 lbs., mailable **399.95***

IO-105 SPECIFICATIONS — VERTICAL — Accuracy: ±3%. **Input impedance:** 1 megohm shunted by 35 pF. **Maximum input voltage:** 600 VDC. **Sensitivity:** AC or DC, 0.05 V/cm. **Frequency response:** DC to 15 MHz, 3 dB with 4 cm deflection. **Vertical windows:** 2 minimum. **Rise time:** 24 ns. **Overshoot:** Less than 10%. **Attenuator:** 9 positions in a 1, 2, 5 sequence. 0.05 V/cm to 20 V/cm, ±3%. Variable gain (uncalibrated) thru entire range. **Vertical display in sweep mode:** Channel 1, Channel 2, Channel 1 & 2 alternately; or Channel 1 & Channel 2 chopped (50 kHz). **HORIZONTAL — Time base:** Triggered with 18 calibrated rates, 0.2 us/cm to 100 ms/cm in a 1, 2, 5 sequence, ±3%. Continuously variable (uncalibrated) within the same range. **Sweep magnifier:** x5 (time base accuracy is ±5% when the magnifier is being used). **External horizontal input:** 750 millivolts/cm (uncalibrated & not adjustable). 100 K ohm minimum input impedance, DC to 100 kHz. **X-Y MODE — Sensitivity:** 0.05 V/cm to 20 V/cm, ±3%. **Frequency response:** −3 dB @ 100 kHz (Channel 2). **Phase shift between channels:** ±5° or less from DC to 50 kHz within graticule limits. **TRIGGERING — Delay:** Approx. 600 ns. **Auto:** Zero crossing ±½ cm of zero crossing. **Norm:** Within viewing area. **Source:** Channel 1, Channel 2, or Channels 1 & 2. **Polarity:** + or − slope. **Coupling:** AC or DC. **Sensitivity:** Internal, ½ cm; external, 100 mV minimum, 7 V max. **GENERAL — Blanking in:** TTL compatible (Logic 0-blank). **Gate out:** 3.5 volts minimum. **Input connections:** Vertical, coaxial & BNC; horizontal, binding post; external trigger, binding post on ¾" center with ground. **CRT accelerating potential:** 2200 VDC regulated. **CRT type:** 8x10 cm, rectangular, flat-face, D14-107GA. **Retrace suppression:** DC coupled unblanking of the CRT. **Graticule:** 8 cm x 10 cm grid, edge lighted. **Power requirements:** 105-125 or 210-250 VAC, 50/60 Hz, 60 watts. **Warm-up time:** CRT heating time, approx. 30 seconds; for full calibration, approx. 15 minutes. **Overall dimensions:** 12⅜" H x 10⅝" W x 15" D. **Note:** Specifications measured at 25° C with 120 VAC line voltage.

The Heathkit IO-102 general purpose scope combines the virtues of top performance, maximum convenience and low cost. All solid-state design is your assurance of long-term reliability under sometimes rough shop conditions. Wide 5 MHz bandwidth, 30 mV/cm sensitivity and 80 nanosecond rise time add up to truly unusual value at this low price. Switch-selected AC or DC coupling adds extra convenience and versatility. Frequency-compensated 3-position attenuator accommodates varying input levels. A separate switch position grounds the input to provide a zero reference line. One megohm FET input minimizes circuit loading. The recurrent, automatic sync type sweep generator provides continuous sweep from 10 Hz to 500 kHz. Front panel external horizontal and sync inputs. One volt P-P output included. The 5" flat-face 5DEP1 CRT gives a brilliant, highly visible trace, even in high light levels. 6x10 cm ruled graticule makes amplitude easy to determine. All supplies are zener-regulated to give the IO-102 excellent display stability. 120/240 VAC wiring options. Put this top value scope to work for you now.

Kit IO-102, 31 lbs. **119.95***

Assembled IOW-102, 29 lbs. **179.95***

IO-102 SPECIFICATIONS — VERTICAL CHANNEL — Sensitivity: 30 mV/cm, uncalibrated. **Frequency Response:** DC to 5 MHz, ±3 dB. **Rise Time:** 80 nanoseconds. **Input Impedance:** 1 megohm shunted by 35 pF. **Attenuator:** 3-position, frequency compensated; x1, x10, x100. **HORIZONTAL CHANNEL — Sensitivity:** 0.1 V/cm. **Frequency Response:** 1 MHz ±3 dB. **Input Impedance:** 1 megohm shunted by 50 pF. **Sweep Generator-Type:** Recurrent, automatic sync. **Range:** 10 Hz to 500 kHz in five switch-selected steps, continuously variable between steps. **GENERAL — Cathode Ray Tube:** Type, 5DEP1, green medium persistance phosphor. Viewing area, 6x10 cm. **Power Supplies:** All solid-state rectifiers. All amplifier supplies regulated. **Power Requirements:** 120/240 VAC, 50-60 Hz, 35 watts. **Overall Dimensions:** 12¾" H x 9¼" W x 16¼" L, including knobs, handle, feet, etc.

See these kits at your local Heathkit Electronic Center... or fill out the coupon at right.

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CIRCLE NO. 20 ON READER SERVICE CARD

Towers bristling with TV antennas, such as these at a Jerrold system in Harrisburg, Pa., were main source of signals for CATV. Now, operators originate signals of their own.

The winding road to Cable TV may lead to more and better viewing

CABLE TV—

CABLE TELEVISION is an enigma. The further it goes, the harder it is to tell just where it is going. When it was simply community antenna TV (CATV), it provided the simple, basic service of bringing TV reception to those areas that broadcast stations could not reach. But 22 years have brought about changes. Purposes and outlook have changed—not to mention the name.

Today's cable TV is a system for delivering many channels of TV to home receivers by wire (coaxial cable). Some channels deliver nearby station programs that you would receive anyway. Others carry signals imported from distant stations, picked up by powerful antennas and relayed by microwave. At least one channel can carry programs generated by the cable owner (often including commercial advertising). This is no longer a simple multi-customer antenna service. It is *cablecasting*. The term "CATV" belongs to a bygone era.

By The Numbers. You can gauge the significance of cable TV by the way it has grown. In spite of powerful and determined opposition, its proliferation has been fast and steady over the past six years.

More than 2500 cable TV systems presently serve 4.6 million homes in some 4300 communities. Roughly 15 million, or about 7 percent, of the nation's viewers daily watch cable-delivered TV. For this service they pay $4.50-$6.00 monthly—an annual gross revenue for cable owners approaching $300 million.

But is cable TV profitable? Look at it

this way: Monthly operating costs seldom exceed $2.50 per subscriber. Before-tax operating profits run 50 percent or better. Investment stands at about $600 million, and the return on that investment usually is about 20 percent. With figures like these, cable TV attracts plenty of capital.

The cable TV concept is a mover. One reasonable estimate anticipates that half the country (30 million homes) will be on cable by 1980. At least 7500 systems will be needed to serve the communities involved, and cable owners will invest about $5 billion in facilities. Annual revenues could exceed $3 billion. Commercial broadcast TV grosses about this amount from advertising right now.

The whole country will eventually require as many as 15,000 cable systems feeding into 60 million homes and, says one analyst, 20 million businesses. By that time, however, the character of cable TV will have changed again, and a new term will outmode "cablecasting."

Ups & Downs. Cable TV takes new turns every month. Last summer, cable owners began putting their own programs on one channel. The programs are limited mostly to live community news and sports and to old movies. Few are in color. But the effort is there.

Where It Is & Where It's Going

BY FOREST H. BELT

(The Federal Communications Commission tried to mandate original programming on at least one cable channel. But Midwest Video Corp. appealed the order and a US Court of Appeals ruled that cable owners are not required to originate their own programs. But other FCC dictums keep altering the industry's direction.)

Telephone companies own 20 percent of the cable systems. According to the FCC, they cannot operate both telephone service and cable TV. Hence, they have just three years to dispose of their systems.

Networks are now forbidden to own cable systems. Nor can a station operate a cable system within its own coverage area. Consequently, CBS has made a separate firm of its cable companies. (ABC and NBC have no cable interests to sell off.)

If the FCC has its way, the networks will not be permitted to produce programs for either over-the-air or by wire syndication. This limits the sources of programs for the cable owner. It also precludes networks from eventually feeding cable TV systems. But this particular obstacle may not prevail.

New systems are not coming into being as often as they did before. One reason is that cities hesitate to grant franchises. The question of jurisdiction is not resolved. Whether cable franchising should be controlled by the FCC or handled by city or state utility commissions is still up in the air.

The FCC may decide to issue licenses to cable owners as they do with broadcasting stations, allowing the cities a small franchising fee. The few states that do regulate cable TV take varied approaches. So, for the sake of national uniformity it appears that the FCC will have to do the regulating.

A ban already exists against importing signals into the top 100 TV markets. Some people think that importation is unfair to local stations and advertisers. The FCC proposes reducing the ban to only the top 50 markets. Commercials would be deleted and local ads inserted in their places. The idea, however, is technically impractical, necessitating the need for some other solution.

The ban has not been ironclad. New York City, for example, is being wired for cable by two companies. The FCC waived the ban, and it may do the same for other large cities. What happens in New York may provide an answer to one key question: Can cable TV be profitable in urban areas where stations are already plentiful. Indications are that it can. About 70,000 subscribers are already signed up in New York, and some 3000 more apply every month.

Maps of Utopia. One test of cable TV's value is performance. What can it do for you that is not already being done? Cable proponents make promises—some for now, others for the long haul. A few are likely to be realized, and a few are not. Many rely on unproved technology.

Cable operators now generate their own live programs on one channel. This TeleMation-equipped studio cablecasts black and white.

Variety of programming sounds like a reasonable solution since modern cable systems can accommodate 20, 30, even 70 channels. But consider what might go on these channels.

Suppose that 10 channels are used for nearby commercial and educational TV broadcasts. The cable owner programs one channel with his own originations, provides another channel for time and weather reports, and leaves a third for local school and club news and announcements. This puts only 14 channels to use. Let us say that he imports 10 distant TV station signals. Likely some are network and duplicate programs on local channels. The upshot is that you may not find the variety you were led to expect, but it is more than you would get without cable TV.

Quality of programming is another promise. Culture, education, entertainment, and community improvement all sound nice in a proposed package. All are technically possible, too. But where to get the financing, producers, directors, talent, and technicians to make the venture a success is the big problem.

It is folly to believe that cable TV can provide more reliable programming than has commercial TV, even granting that it will try harder. Nor will it do to attract the talent away from broadcast TV. This will only dry up those imported and local channels.

Hometown talent provides a possible out. But mediocrity in today's network attempts draws enough fire. Local productions tend to be even less professional.

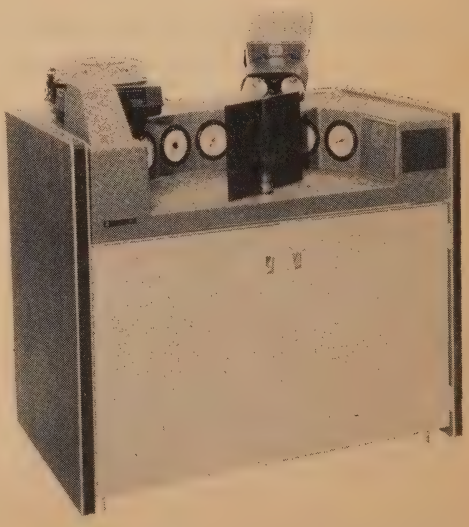
If you envision an end to commercial advertising, forget it. A cable owner sells advertising for his own channel and often for his weather channel as well. He can commercialize on his channels that provide only music. Local TV and FM channels carry whatever commercials accompany their programs. So far, imported channels do the same; and even if commercials are deleted, local ones will probably be substituted.

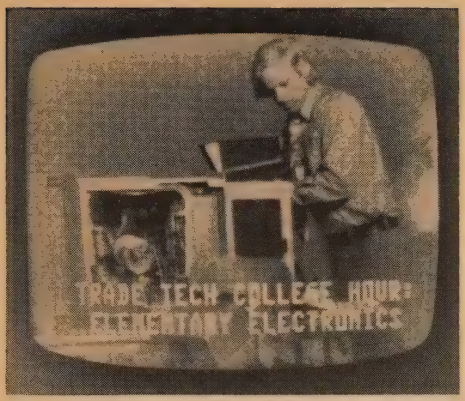
Working Both Directions. Just around the corner is two-way cable TV. It will open a whole new era. With it, you get into true communication by cable. The term to describe such a system might be *cablecom*.

From thoughts of nationwide two-way cable TV grow some of the "blue-sky" notions you hear about. For example, there is subscriber-to-subscriber hookups. It demands complicated but not impossible switching. Then there are the "office at home"; the long-awaited home computer terminal; newspapers, magazine articles, books, etc., that can be delivered to your home video/copier on demand. None of these is farfetched.

You would perform your own program-

Weather scanner complete with gauges used by some cablecasters. The scanning mirror reflects readings on gauges and card announcements to camera above. Music is sometimes also transmitted on this same channel.





This video display is coded by a special character generator used by the cablecaster.

ming by punching the proper buttons to a central library of stored video and audio tapes. You could transmit and receive letters on your home copier, although distant ones might go through a post-office-type exchange. You could even job-hunt and be interviewed by cable TV.

These fantasies are not called blue-sky because they are not possible. They *are* possible. It is simply that they are more expensive than you can now afford. Cable owners agree to add services such as these "as technology permits and subscribers demand" them. This is a polite way of saying that, when the majority of subscribers can afford it, they will get a particular service.

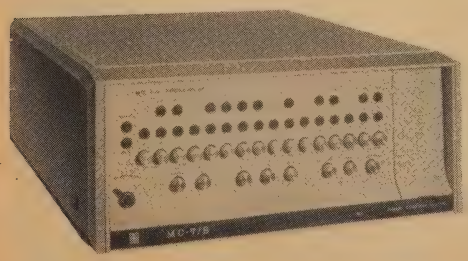
Some two-way transmissions would be truly worth their cost. Special cable-com channels allocated to hospitals, doctors, and medical schools would speed and simplify information exchanges, consultations, and studies. Home receivers would not pick up these channels unless at-home care were needed. Law-enforcement agencies would have like facilities. Home and business security alarms could instantly and directly alert police, fire, and protection agencies of anything that might go wrong while you were away.

Japan Broadcasting Co. runs a high school at home by one-way TV. Just imagine how much more effective the learning process could be if the system were two-way. Why, even earning a college degree through TV is far from impractical.

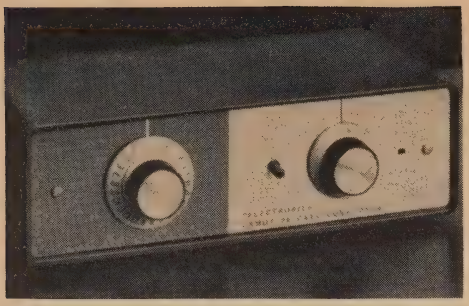
Outlook With Cable. How will cable TV affect you? For one thing, it will take more out of your pocket. "Free TV" costs your family $50 a year in higher prices for the advertised products you buy. For cable service, you pay about $60 a year. You get more programs, but they are still accompanied by commercials. The result is that cable TV will mean an add-on cost to you; the cost of the products you buy *plus* your subscriber fee.

A unit that looks and operates like this Panasonic video-display computer terminal could take the place of your present TV.

A minicomputer, such as this one, could be hooked into a cable communications system, and could talk with central computer from "office at home." Ideas such as this are costly but within the realm of possibility.



You will not be affected much by how cable TV operates electronically, but you may be interested just the same. Dial-a-program systems are being tried here (similar to the one in Great Britain). The receiver has no tuner, just a phone-type dial. Numbers of the program channel are dialed in and pulses cause a central exchange to hook the cable to one of perhaps 70 program channels. Interconnected countrywide, these systems might well form the basis



A new Oak 26-channel CATV converter for a conventional TV receiver. Simple controls include channel-selector switch, fine-tuning control, power switch, and pilot light.

TOP TEN U.S. CABLE OPERATORS

Company	Number of Subscribers
TelePrompTer[1]	535,000
Cox Cablevision Corp.	179,000
American TV & Communications	178,000
Viacom[2]	150,000
Community Tele-Communications[3]	142,000
Cypress Communications Corp.	140,000
Cablecom-General	123,000
Time-Life Broadcast Inc.	106,000
Jerrold Corp.	100,000
Midwest Video Corp.	90,000

Notes:
1. Includes mergers with H & B Communications Corp. and Reeves Broadcasting Corp.
2. Systems formerly owned by Columbia Broadcasting Systems.
3. Includes merger with Centre Video Corp.
(Table courtesy NCTA)

for home-to-home cable communications.

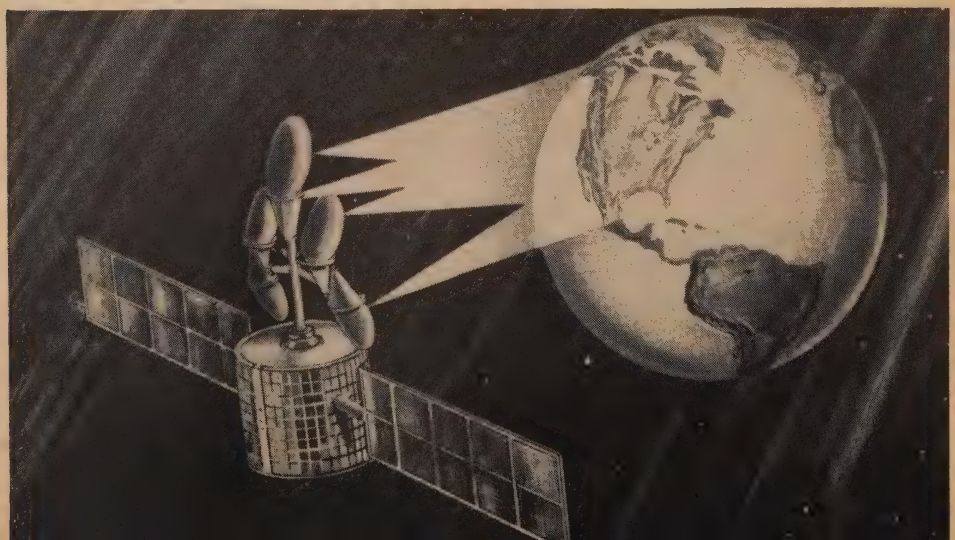
A satellite or two could distribute cable TV for the whole country. Proposals for the grand plan are already in the works. Intelsat-type satellites carry a dozen or more TV channels. New digital techniques for transmitting color TV signals can double this figure by taking less spectrum space. And two dozen channels should be enough for nationwide network coverage.

Microwave is already being used for regional networking. Infrared and laser beams are being studied as another universal possibility for broadband communications like cable. And one company is experimenting with microwave delivery directly to the home.

The pictures you view from cable could look better than those of today. Finer definition and smoother, truer color are possible. A cable system can decode the TV signals it receives by present standards and revamp them to much higher standards. Imaginative cable operators may grab at an opportunity like this.

The existing cable TV system leaves much to be desired on the technical side. But you would need a new kind of TV receiver for the things that can be done and are not far away. Do not look for any great changes to be made right away. When they come, they will be costly for the subscriber as well as the cable company and so will come in gradually. ◈

The technology exists now to distribute cable television over a satellite network to stations on the earth (conveniently located for distribution). This plan is from a Sylvania system. Economics will determine whether this particular method will be used.



How Much Current Is Fatal?

THE FOLLOWING information, supplied by Tektronics Inc., is something we feel should be read and understood by all electronics experimenters, technicians, hams, and engineers, regardless of what area of electronics or electrical work they are in.

Unfortunately, most of us think that a shock of 10 kV would be more deadly than one of 100 volts. This is not so. People have been electrocuted by ordinary 117-volt appliances and by voltages as low as 42 volts dc! The real measure of the degree of shock is not the voltage applied, but the amount of current forced through the body—and that need not be very much.

While any amount of current over 10 mA is capable of producing a painful to a severe shock (as shown in the chart), current between 100 and 200 mA can be considered lethal. Currents above 200 mA, while producing severe burns and unconsciousness, do not usually cause death if the victim is given *immediate* resuscitation (artificial respiration).

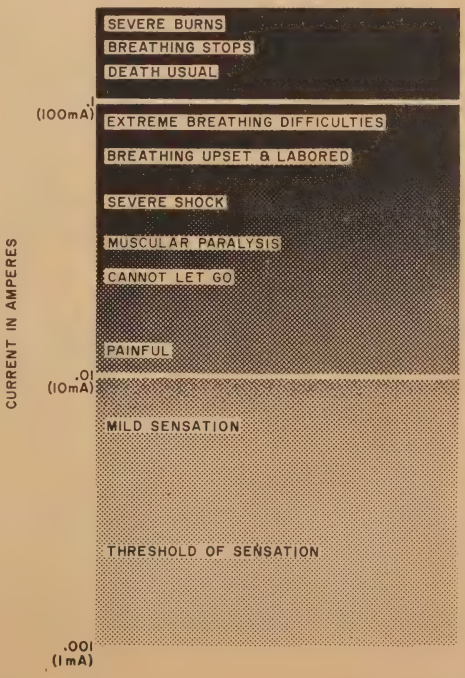
Voltage is not a consideration; it is important only because its level and the body resistance between the points of contact determine how much current flows. Since resistance varies greatly, it is impossible to predict a dangerous voltage. The resistance may vary from 1000 ohms for wet skin to over 500,000 ohms for dry skin—remembering that the resistance from point to point under the skin may be only a few hundred ohms. Also remember that the contact resistance decreases with time and the fatal current may be reached rapidly.

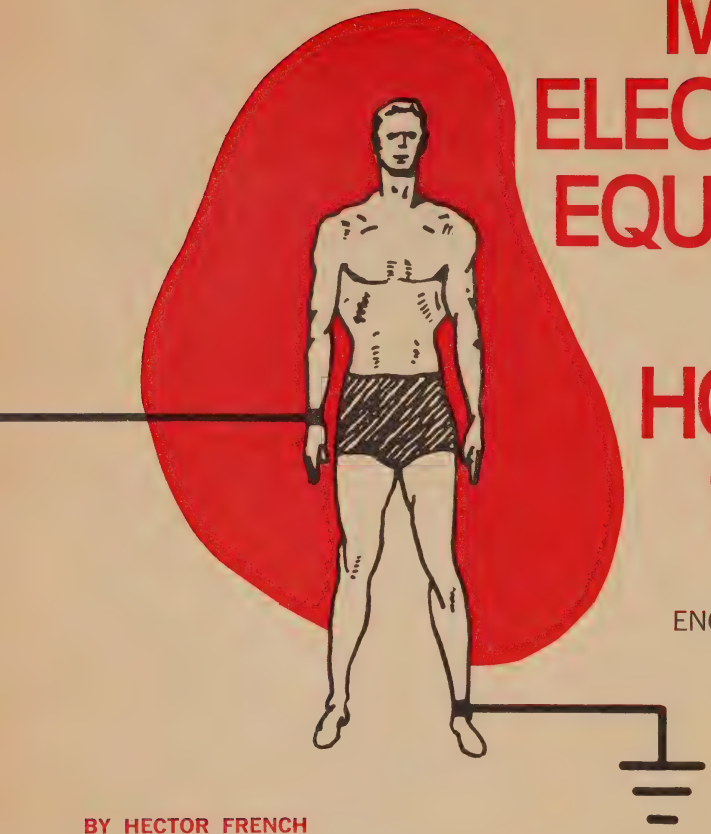
As shown on the chart, a current as low as 20 mA is very dangerous and painful, and the victim can't let go of the circuit. As the current approaches 100 mA, ventricular fibrillation of the heart usually occurs. Above 200 mA, the muscular contractions are so severe that the heart is often forcibly clamped during the shock. This clamping sometimes protects the heart from going into ventricular fibrillation and the victim's chances for survival are good.

Now, what lesson can we learn from all of this? First, regard *all* voltage sources (even some batteries) as potential killers. When working around electrical equipment make sure you know where you are with respect to the voltage source. Don't lunge after fallen tools. Kill all power before diving into circuits. Don't work when you are mentally or physically fatigued. Keep one hand in your pocket when investigating live electrical equipment. Be particularly observant of what you are standing on—don't work on a metal floor, damp concrete, or any other well-grounded surface. Don't handle electrical equipment while wearing damp clothing—particularly shoes—or when the skin is wet from water or perspiration.

In the event of an accident, either cut the voltage or get the victim away from his contact—using some form of insulation to do the job or you will get caught too. If the victim is unconscious and has stopped breathing, start artificial respiration at once. Do not stop until proper medical aid has arrived. ◈

It's not the voltage that causes the big problems, but the current level being driven through body tissues.





MEDICAL ELECTRONIC EQUIPMENT AND HOSPITAL SAFETY

MEDICAL EXPERTISE, ENGINEERING KNOW-HOW, AND HOSPITAL EXPERIENCE SPELL SAFETY FOR PATIENTS

BY HECTOR FRENCH

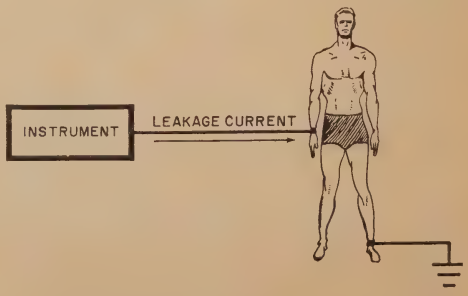
MANY VISITORS to today's hospitals express some degree of surprise at how much electronic equipment is used by the medical profession in diagnosing illnesses and caring for patients. In spite of the popular medical TV shows with their science-fiction-like sets, the visitor is unprepared for the sights he will encounter in a really modern hospital.

It is not uncommon to find patients all over the wards wired up to some type of electronic instrument—from oscilloscopes to voltmeters to recorders to computers. For some patients and visitors, seeing all this electronic gear in use conjures up thoughts of shock hazards.

At one time, when electronics first invaded the precincts of medicine, there was a very real danger of shock hazard to the patient on whom the new equipment was used. But this is hardly the case now. For years, medical engineers and scientists have been working on electrical safety for the patient. They are designing electronic equipment that is hundreds of times safer than the so-called safe appliances you use every day at home.

How much Leakage? In medical elec-

Fig. 1. Body must be grounded when connected to instrument to eliminate interference due to antenna effect.



tronic equipment used on patients, current leakage is extremely important. All electrical and electronic equipment has leakage current, and medical equipment is no exception. So, the first question the designers had to ask was: How much leakage current is *too* much?

If the patient gets *any* sensation from the current it is too much. Considering that the minute he is connected to the equipment he begins to worry, you can imagine how much more worried the patient will be if he feels even the slightest tingle.

One has only to look at the effects various current levels have on the human body. At 1 milliampere through the intact, unbroken skin, the patient will probably feel a very slight tingle. At 10 milliamperes, he will in all likelihood think someone is trying to electrocute him. If the current is increased to 100 mA, then there is a good chance that the patient will actually *be* electrocuted.

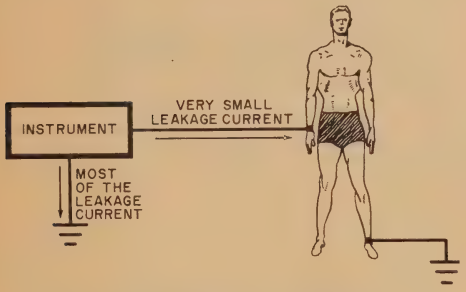


Fig. 2. Grounding both patient and instrument is not as safe as expected.

If the patient is in heart surgery, there is the possibility that the leakage current might flow directly to the ultra-sensitive heart tissue itself, where as little as a few hundred microamperes can be lethal. This tiny current is almost 1000 times smaller than a possible lethal dosage applied through the skin.

The engineer who designs medical electronic equipment and the hospital personnel using it must guard against any instrument or combination of instruments that would allow the current through the patient's body to approach 100 microamperes.

Grounding the Patient. Another problem is that of grounding the patient. Grounding is necessary because the patient's body acts like an antenna, picking up electrical interference that can completely mask the signals the doctor is looking for. Connecting the patient to ground stops the "antenna" effect.

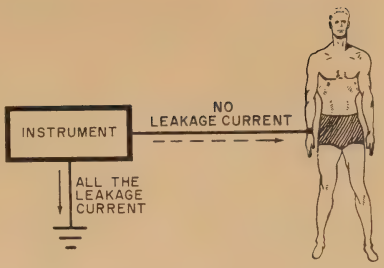


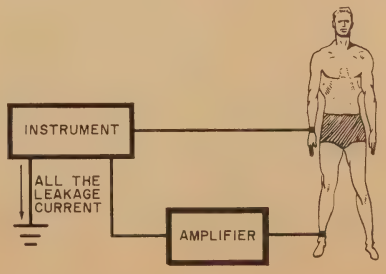
Fig. 3. Ungrounding patient eliminates body current path, but antenna effect returns, making readings useless.

With the patient connected to a suitable ground and to some type of medical instrument as shown in Fig. 1, all of the leakage current from the instrument passes through the patient's body. This is an obviously unsafe situation. The answer would appear to be to ground the instrument as well as the patient as in Fig. 2.

Now, most of the current flows harmlessly to ground, leaving only a very small amount to pass through the patient's body. But closer inspection reveals that this setup is not safe either. The circuit to ground through the patient's body is still there, carrying a small current. Ordinarily, this current would be too small for concern, but if the instrument's ground should become defective, the entire leakage current will pass right through the patient's body once again!

Another potential hazard is that the instrument connected to the patient can fail and pump many hundreds of times the

Fig. 4. Feedback amplifier places patient's body at ground potential without danger of physical connection.



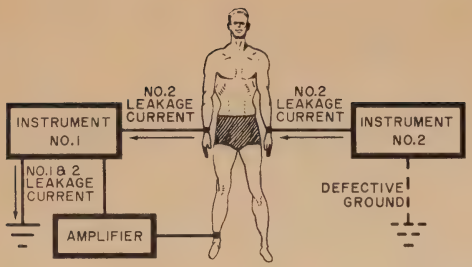


Fig. 5. Even with feedback amplifier, patient is in danger of shock when more than one instrument is used.

ordinary leakage current to the patient. If the patient were in heart surgery at the time, only a few hundred microamperes could spell disaster.

It is clear that grounding the patient and the instrument is not the answer for up-to-date hospital safety. What is needed is some method of operating the instrument without having to ground the patient at all as in Fig. 3. This arrangement eliminates the path to ground through the patient's body so that he would be completely protected against leakage from the instrument.

A Better Way. There is one big drawback to the arrangement shown in Fig. 3. It will not work! Remember that if the patient is not grounded, his body acts like an antenna and picks up interference. To make this setup practical, the patient's body must be brought to ground potential without actually connecting him to ground.

There is nothing tricky in this. As shown in Fig. 4, it is accomplished by adding a "bucking-out" feedback amplifier. Built right into the instrument, this amplifier adds just the right amount of voltage to bring the patient's body to ground potential without a physical connection to ground. In this manner, the instrument is prevented from sending any leakage current through the patient, and there is no interference from the antenna effect.

For ultimate safety, however, even this system may not be enough. While the patient is protected well enough when there is only one instrument, two or more instruments (see Fig. 5) complicate matters enormously. The leakage current from instrument No. 2 still flows through the patient's body to ground. And while not grounding the patient with one instrument may be a solution, there is a greater possibility of failure with two or more instruments. Although the possibility of failure may be remote, if it *can* happen at all, a safety-oriented design must guard against it.

High-Isolation Inputs. There is a solution, using "high-isolation" inputs, that provides state-of-the-art patient safety. Built into the medical electronic instruments, the isolation circuits are so effective that their action is measured in terms of the many megohms of isolating resistance that they appear to insert between the instruments and the patient. In many instruments, 30 megohms is a common value.

Even if the ground circuit is defective (see Fig. 6), this isolation protects the patient with any number of instruments connected. If, for example, instrument No. 2 should develop a defective ground, there will still be a leakage current through the patient, but the isolation is so great that the leakage current is limited to a wide margin of safety. It is so low, in fact, that

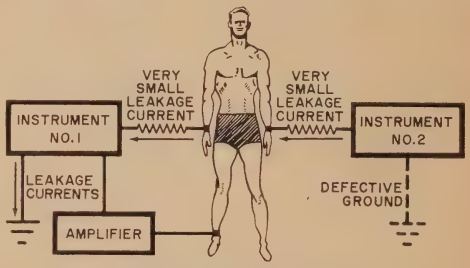
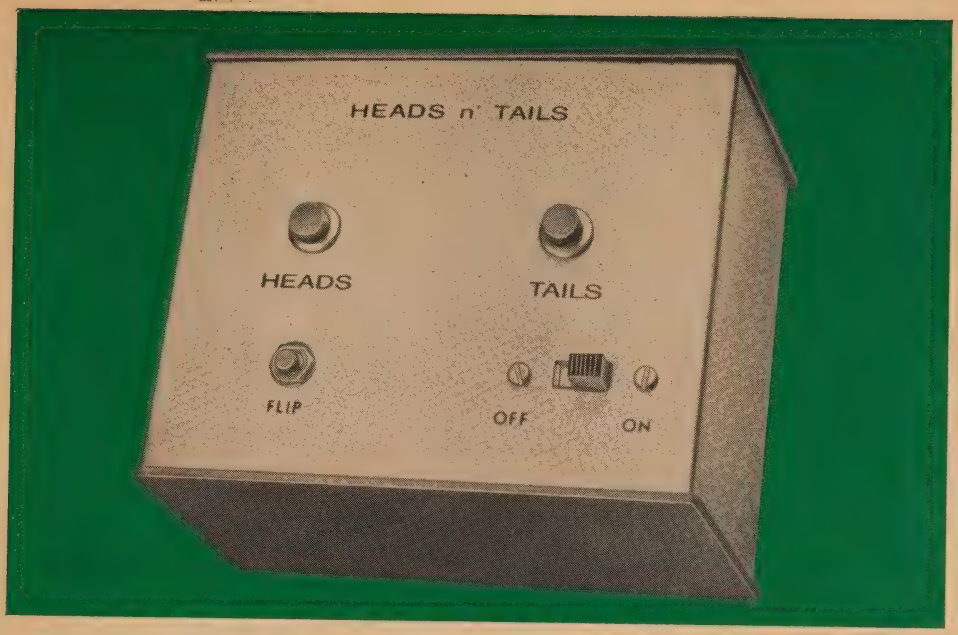


Fig. 6. Safest hookup is shown here. In addition to amplifier, current-limiting high-isolation inputs are used.

even a number of such instruments being used at the same time during open-heart surgery will not provide cause for alarm.

You might be wondering about the "human error" involved in the use of medical electronic equipment. This is understandable. But, again, there is little cause for alarm; hospital staff personnel are well trained in the handling and use of any equipment designed for diagnostic and/or patient monitoring purposes.

The next time you are in a hospital, either as a visitor or as a patient, you can lay to rest any fears you might have with reference to shock hazard. Everything possible—medical expertise, engineering know-how, and hospital safety experience—are on the side of the patient. ◈



HEADS 'n' TAILS

ELECTRONIC COIN FLIPPER GIVES YOU A FAIR SHAKE

BY JIM CRAWFORD

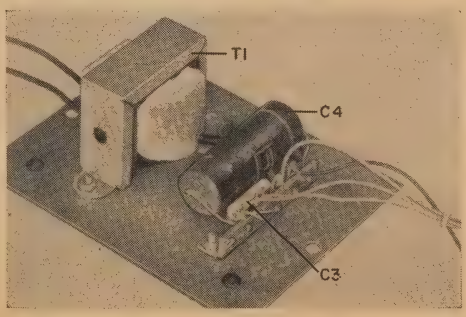
MOST ELECTRONIC games that, in effect, flip a coin are designed to give "the house" an advantage—not so the "Heads 'N' Tails." It's strictly on the up-and-up with an exact 50-50 percentage, unless the circuit is tampered with. The project is ideal for school laboratories as a probability demonstrator or study aid. It is also good for a science fair project—or simply as a means of determining who buys on the next coffee break.

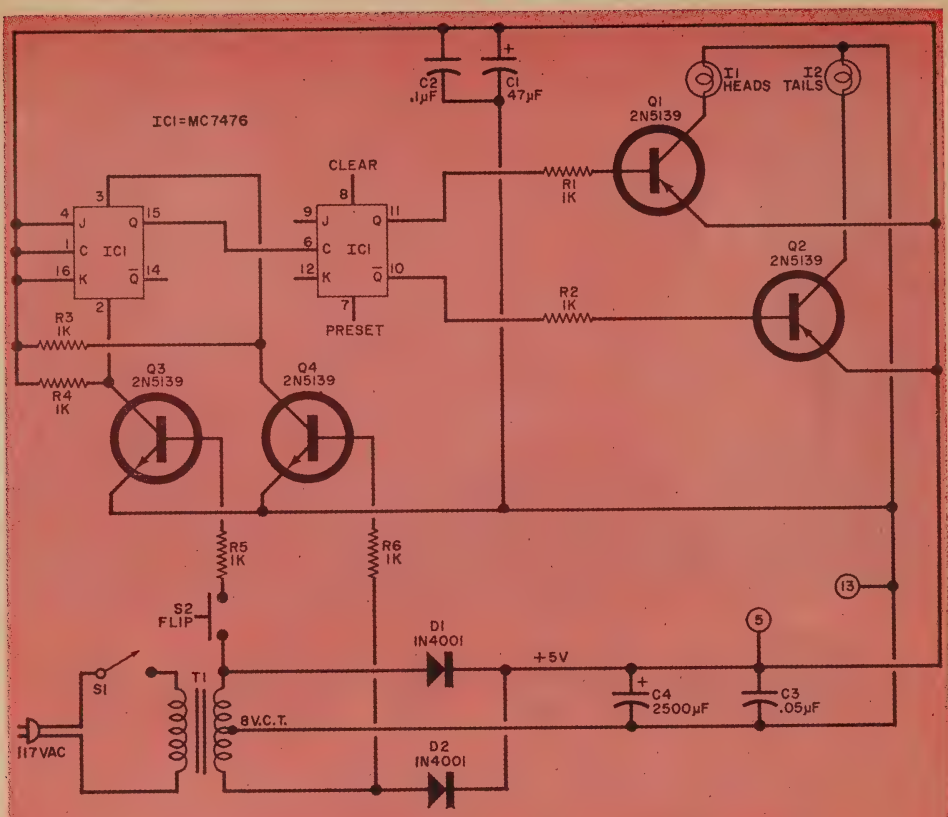
The simple circuit, shown in Fig. 1, uses a transistor-transistor-logic IC and four low-cost transistors. The visual readout of the second flip-flop indicates heads or tails.

Rather than using an astable, or some other potentially unsymmetrical "odds determinator," the Heads 'N' Tails counts the power line frequency so that both the length of time the pushbutton is held down and the phase of the power at the instant the pushbutton is depressed combine to provide a truly random 50-50 long-term result.

In the first JK flip-flop only the direct inputs (clear and preset) are used so that the circuit squares up and follows the power line frequency as long as S2 is closed. Transistors *Q3* and *Q4* alternately set and reset the flip-flop immediately after each sequential power line zero crossing. The

The power supply is a conventional two-diode, full-wave rectifier and filter mounted on the bottom plate.





PARTS LIST

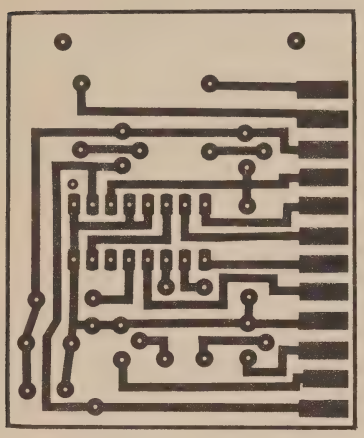
C1—47-μF, 15-volt electrolytic capacitor
C2—0.1-μF, 10-volt disc ceramic capacitor
C3—0.5-μF, 10-volt disc ceramic capacitor
C4—2500-μF, 10-volt electrolytic capacitor
D1,D2—1N4001 (or similar) rectifier diode
IC1—Dual JK flip-flop (Motorola MC7476 or Texas Instruments SN7476)
I1,I2—5-volt, 50-mA lamp (one green, one red)
Q1,Q2—2N5139 transistor
Q3,Q4—2N5129 transistor
R1-R6—1000-ohm, ¼-watt resistor
S1—Spst slide or toggle switch
S2—Normally open spst pushbutton switch
T1—Transformer; secondary: 8 VCT at 500 mA
Misc.—Suitable chassis, line cord, strain relief, mounting hardware, etc.
Note—The following are available from Southwest Technical Products, Box 16297, San Antonio, TX 78216: etched and drilled PC board #187 at $1.85; complete kit of all parts including punched and finished case and power supply #187C at $8.65, plus postage and insurance (optional) for 2 lb.

Fig. 1. The flip-flops count the power line frequency when S2 is held down. The state of the flip-flops is then indicated by the pilot lights.

Q output of the first JK is a noise-free square wave when S2 is closed, and either a logic 1 or 0 when the switch is open.

The output of the first flip-flop is used to cycle the second JK which is connected as a binary divider. One of its outputs drives the "Heads" indicator lamp, and the other drives the "Tails" lamp. Transistors *Q1* and *Q2* provide sufficient power for the flip-flop outputs to drive the lamps. When S2 is closed, both lamps cycle on and off 30 times a second—a speed much faster than the eye can follow, to discourage cheating.

Construction. Although any construction technique can be used, a printed circut board such as that used in the prototype is recommended. A foil pattern and compo-



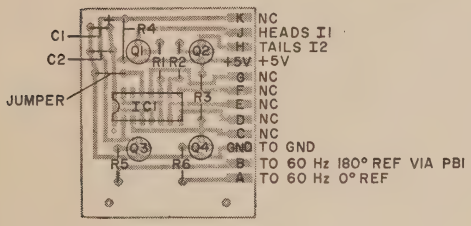
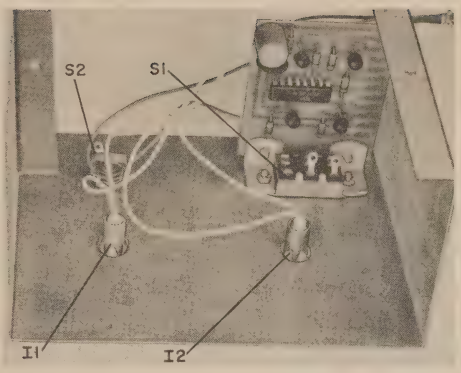


Fig. 2. Actual size foil pattern and component installation. The edge connector is used to facilitate removal.



The board mounts on a pair of angle brackets and doesn't take much room.

nent layout are shown in Fig. 2. Note that one jumper is used on the component side of the board. When mounting the IC, observe the notch and dot code marks. Use a low-power soldering iron and fine solder.

The power supply, which can be used in other projects, is mounted on a separate board.

The project is very simple to use. With power applied, turn on *S1* and depress *S2* for as long as desired. Both lamps will glow. When *S2* is released, only one lamp will remain lit. ◈

TAKING A LAST LOOK AT SOLAR ENERGY PANEL

During final tests at Hughes Aircraft Company, engineers and inspectors are taking their last look at the extended solar panels of the FRUSA (Flexible Rolled-Up Solar Array) system, which is now converting solar energy into electrical power for orbiting satellites. Developed by Hughes for the U. S. Air Force Aero Propulsion Laboratory, Wright-Patterson AF Base, Ohio, the panels, which contain more than 34,000 solar cells to convert the sun's energy into 1500 watts of power, were unfurled in space after being launched Oct. 17, aboard a Thor-Agena satellite. The FRUSA has a 400-mile-high polar orbit. Snugly rolled like windowshade on the 10-inch diameter cylinder during launch, the panels were extended in space by metal booms, which are wound and stored in metal cassettes at each end of the cylinder. Both panels, each measuring 16 by 5½ feet, are shown fully extended on blocks floating in a water-filled table to simulate zero gravity during final process of being wound under tension onto the cylinder.

Today's Army is helping to save lives on the highway.

Doctors agree that many more accident victims could be saved, if they could get skilled treatment in time.

The United States Army is trying to save more of these lives. They're doing it with helicopters and Army trained evacuation teams.

They call the project MAST. Military Assistance to Safety and Traffic. In three experimental areas of the country MAST teams are on 24 hour alert. Trained pilots, skilled medical aid men, communications experts.

They can be in the air in two minutes. Get to the victims quickly. Start treating them immediately. Lift them out promptly and get them to the area hospital that is best equipped to handle each case.

And MAST is working.

In all three experimental areas it is saving the vital time that saves lives in accidents.

MAST. Military Assistance to Safety and Traffic. A good example of how today's Army fights a lot of the things none of us want.

Today's Army wants to join you.

Labyrinth Speakers for HI-FI

SOME PROBLEMS AND SOLUTIONS ALONG WITH ADVICE TO EXPERIMENTERS

BY DAVID B. WEEMS

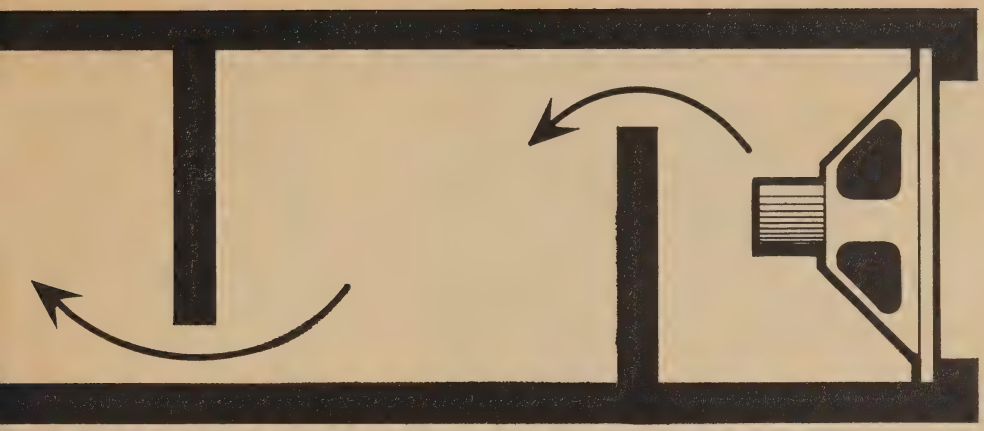
OF THE BASIC types of loudspeaker enclosures, most are produced as classic designs by the various manufacturers of speaker systems. However, one basic design is carefully avoided. A representative of one manufacturer recently offered praise for the neglected design, although he concluded: "Of course, it isn't commercially practical." He was speaking about the labyrinth, an open-ended pipe connected to the back of a speaker.

In the 1970's, any speaker enclosure to appear on the market must compete in size, cost, and performance with the simplest of enclosures: the sealed box. According to the rules of the game, the large labyrinth comes up to bat with two strikes against it. Hence, it must win on performance alone.

Pro's and Con's. When Benjamin Olney first developed the labyrinth for Stromberg-Carlson in 1936, the chief competition was the boomy open-backed cabinet of the console radio. In the 1950's S-C introduced their "acoustical labyrinth" to the component hi-fi market. But later S-C abandoned the consumer market, and the commercial life of the labyrinth came to a tentative end. In recent years, however, it has been revived by Admiral Corp. and IMF Products.

Partisans of the labyrinth claim that its dual bass source delivers more impact with less of the "boxy" sound of other enclosures. Britain's E. J. Jordan, for example, states that it offers the purist probably the cleanest method of absorbing back radiation from a speaker.

One measurable difference between the labyrinth and the sealed box is the former's



extremely smooth impedance curve. Many engineers contend that because modern amplifiers operate as constant-voltage sources, the impedance curve is not too important. Labyrinth partisans retort that transistor amplifiers are incapable of delivering their rated power into a high-impedance load. So, they say, the single high-impedance peak of a speaker in a sealed box may cause an amplifier to choke its output power or go into distortion at the critical low frequencies.

Labyrinth users also claim a more extended low-frequency response that is not even limited by the speaker's resonant frequency. A panel of British engineers listed the labyrinth and large (25′ long) horn as the enclosures most capable of reproducing the extremely low frequencies. And John J. Virva of Admiral, developer of the company's "tunnel reflex," says, "When a high-compliance speaker is tuned in a tunnel reflex enclosure, it has its effective low-frequency power delivery extended by at least one octave."

But what about the power handling ability of a high-compliance speaker in an open-ended pipe? Virva states that the greater efficiency of the pipe takes care of the problem. "Because there is such a significant increase in the sound output from such a system, the power input requirements or driving power are substantially reduced," he says, adding that the emphasis should be on the advantage of reduced input requirements; the listener should be interested in maximum sound output as opposed to maximum electrical power input.

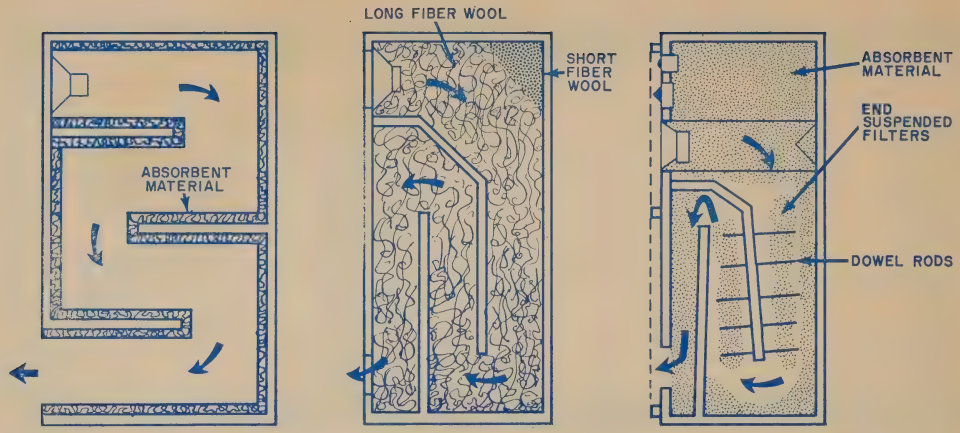
Virva's statements are based on experiments with existing small high-compliance speakers. A designer of large sealed-box systems is free to design a woofer with a subsonic resonance. Such a woofer would not need the extra octave of bass if the system resonance were planned to fall at the bottom of the desired frequency range.

Why have American hi-fi loudspeaker system manufacturers ignored the full-size labyrinth? This question was put to representatives of Electro-Voice, JBL, Jensen, and University Sound. Their answers were somewhat varied but boiled down to cost and complexity.

The labyrinth is in little danger of becoming extinct. Each time it has been commercially discontinued, the design was carried on by amateurs until it reappeared in some form. Fred Nichols of E-V states, "As long as there is a hobby aspect to high-fidelity, there will be interest in the labyrinth enclosure."

Labyrinth Operation. The labyrinth is a tuned pipe with one open end. When the wave from the speaker reaches the end of the pipe, it spreads out into the listening environment, causing a sudden pressure drop which reflects back through the pipe to the speaker as a rarefaction. At the quarter-wave frequency ($\lambda/4$) of the sound, the air in the mouth of the pipe is at minimum velocity but maximum pressure (Bernoulli's Theorem). This condition produces an accompanying maximum rarefaction reflected back to the speaker cone. Here, the anti-resonant action of the pipe offers maximum damping to the speaker.

At the frequency at which the length of the pipe is a half-wavelength ($\lambda/2$), of the



Drawings show, left to right, interior details of Olney's original labyrinth (1936), Bailey's transmission line (1965), and IMF's "Studio" loudspeaker system (current design). In all cases, the small arrows indicate the direction of the rear radiation from the speaker.

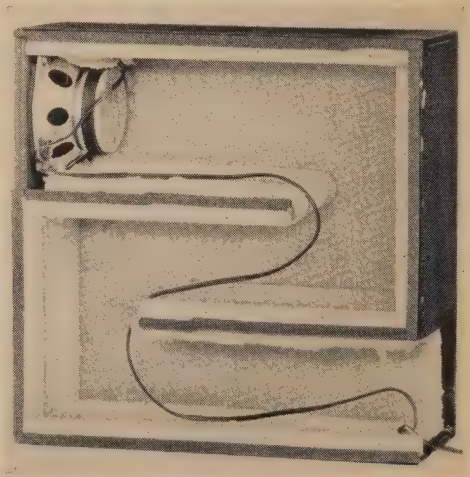
sound, the air in the mouth is at low pressure but high velocity. Because there is no sudden change in pressure as the wave moves out of the pipe, there is no anti-resonant action by the pipe, and the speaker cone is able to move freely. And, because of the $\lambda/2$ phase shift (180°) within the pipe, the emerging wave is in-phase with that coming from the front of the cone, adding to the speaker's output.

The Olney labyrinth utilized a pipe cut to $\lambda/4$ at the speaker's resonant frequency. The $\lambda/4$ action of the pipe damped the speaker's resonance, reducing boom; the $\lambda/2$ action added to the speaker's output in the octave above resonance. Olney chose the $\lambda/2$ frequency to be about 75 Hz. His 8″ speaker had a 50-Hz free-air resonance, reduced to 40 Hz by the labyrinth. (The labyrinth is unique in its ability to lower the speaker's resonant frequency.)

Olney noted the presence of objectionable resonances which were produced as harmonics of the fundamental resonance of the enclosure. To counter this, he lined the walls with sound-absorbing material which, combined with bends in the pipe, eliminated the output from the labyrinth at frequencies greater than 150 Hz.

Recent Developments. Lined tubes were the fashion until Prof. A. R. Bailey of Bradford Institute of Technology developed a "stuffed transmission line." The theory behind it is that an infinitely long acoustic line, or pipe, will absorb the back wave from the speaker without troublesome reflections that can produce standing waves behind the cone. A line of infinite length, of course, would be impractical; so, Bailey substituted stuffing for length. His long-fibre wool stuffing attenuated the back wave so effectively that the sudden pressure changes at the mouth, with their attendant reflections, were avoided. Extremely low frequencies were not attenuated and escaped to increase bass output. Bailey claimed that his transmission line, with its less abrupt low-end cutoff, produced less ringing than conventional ported enclosures.

As shown, Admiral's sound system employs 5¼" high-compliance speaker in quarter-wave tunnel reflex enclosure. Rear wave follows path of the wiring.



IMF has carried the transmission line concept a step further. Irving M. Fried of IMF says, "The transmission line, as we have designed it, is a tapered pipe with variable-density damping . . . which critically damps three resonances—air in the top chamber resonating with the mass and compliance of the driver, tube resonance, and free-air resonance of the driver—thus broadening and extending the band pass."

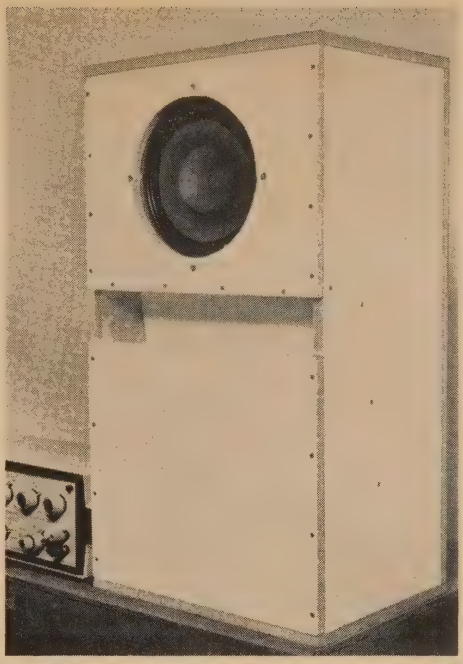
IMF also employs suspended filters, slabs of fiberglass oriented so that the edges of the filter receive the back wave from the cone. The reason for the end suspension is that the flat surface of roll damping material can be reflective at certain frequencies.

Labyrinth Design. The designer of a labyrinth enclosure for a particular speaker must first decide which type of labyrinth to use. He must then consider such problems as optimum cross-sectional area and pipe length. Finally, he must do considerable experimentation to test his design.

Most designers make the cross-sectional area at least equal to the effective piston area of the driver. The figures for effective cone area, however, are generally based on the assumption that the cone acts as a flat piston. A safety factor should be added to a speaker's effective cone area to avoid choking the pipe too much.

An additional safety factor is necessary for IMF's "free-flow" concept. The term implies that the area of the pipe must be equal to the cone area plus the area occupied by the stuffing. There is no simple way to determine exactly how much space is occupied by the solid fibers in a given damping material. But a rough estimate can be obtained by compressing a sample of the damping material to be used to simulate the solid fiber area. The figure obtained from this rough process can then be added to the minimum pipe area.

The classic labyrinth is a $\lambda/4$ pipe. Fred Nichols suggests that it should not be used with some modern component quality speakers, stating that the speakers of the 1930's were underdamped and needed the damping of the pipe to avoid booming at resonance. Component speakers (e.g. E-V's SP12 and SP15) can be used in a labyrinth of $\lambda/4$ to $\lambda/2$ at speaker resonance. "The increase in level from the use of the labyrinth could restore flat response to something approaching the free-air resonance, if done correctly. This could be a spectacular low end once the proper combination of ingredients is found," says Nichols.

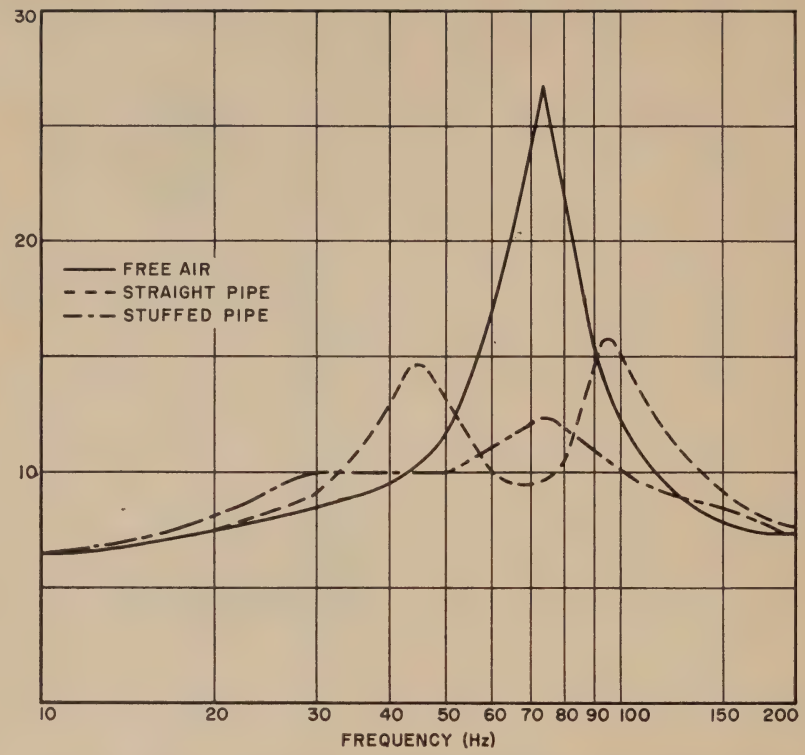


Before cutting wood members, it is suggested you first assemble temporary labyrinth from Celotex and run impedance checks. Some typical curves obtained by author are shown on next 2 pages.

A $\lambda/2$ design for an unstuffed pipe should be used only when recommended by the speaker manufacturer (see table). Most manufacturers base their recommendations on Olney's $\lambda/4$ design. Although Admiral uses a $\lambda/4$ pipe, John Virva says that this is only one mode of operation for the tunnel reflex system. He states that the mean path of the column is chosen to properly augment the low-frequency response of the high-compliance speaker as well as to provide substantial loading for it.

Dr. Bailey's transmission line was set, perhaps arbitrarily, at 7 ft. in length. Jordan states that the minimum length of the stuffed labyrinth should be set at $\lambda/4$ for the lowest frequency produced. Using this specification, the pipe would be 7 ft long for a frequency of 40 Hz. But a stuffed pipe 7 ft long will almost certainly act longer since the stuffing retards the passage of sound and effectively lengthens the pipe.

Dale Nussdorfer (University Sound) mentions another gremlin that can increase



Impedance (ohms) of speaker in quarter-wavelength straight pipe. Action of unstuffed pipe is similar to that of the classic base reflex enclosure.

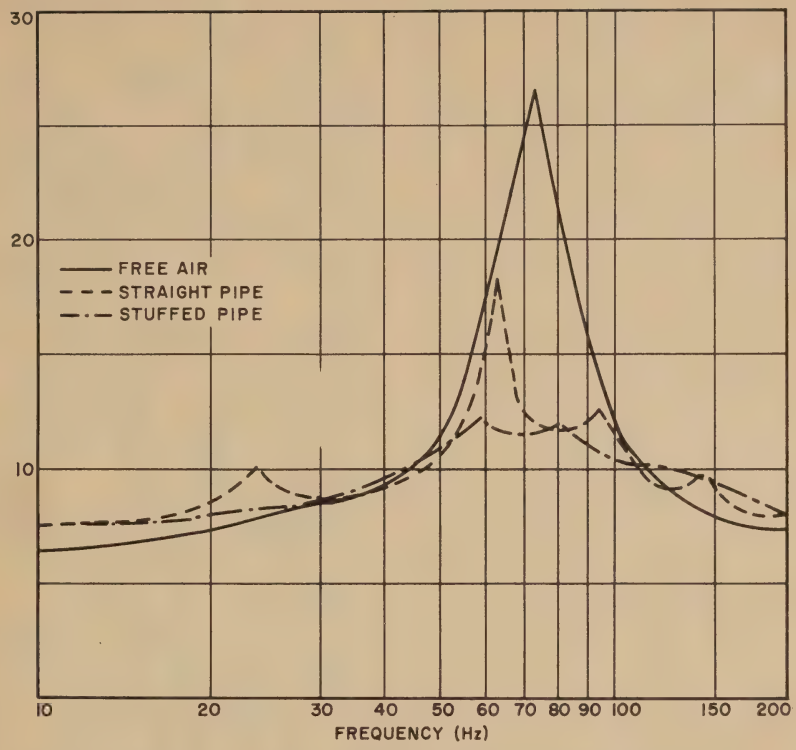
MANUFACTURER RECOMMENDED SPEAKERS FOR LABYRINTH

Admiral Corp.:	(Markets only complete systems using small high-compliance speakers)
Electro-Voice:	Models SP12,SP15; $\lambda/4$ to $\lambda/2$ suggested labyrinth length
IMF Products:	(Markets only complete systems: "Studio" and "Monitor")
JBL:	(None recommended)
Jensen:	High-compliance Models W15LF, W15NF, L12LF, W12NF, etc.; $\lambda/4$ suggested labyrinth length
University Sound:	All cone speakers except Model GS-100; $\lambda/4$ suggested labyrinth length

effective length: "The effective length of a tube is longer due to the friction of the air against the walls. But a bent tube has sharp corners for the air to pass around, and this will cause the friction to increase."

The factors of stuffing and bending may explain why the IMF speakers operate at $\lambda/8$. The performance of a straight open pipe can be predicted but for a pipe that is both folded and stuffed, one needs a crystal ball.

Practical Approach. If you want to experiment with the labyrinth, a good way of negotiating the difficulties is to build a straight pipe of the length, cross-sectional area, and type desired and run an impedance curve with the speaker installed (see "Rally Round The Reflex," Part II, Dec. 1969, for details on how to run an impedance curve). Then make adjustments on the folded pipe until similar results are obtained. Cost and time can be saved by using Celotex as the



Impedance (ohms) of speaker in approximate half-wavelength straight pipe. Note that longer pipe, when stuffed, produces flattest impedance curve.

material for the temporary enclosure; one 4 x 8′ sheet will be enough for an 8 ft pipe with maximum internal cross-sectional area of about 120 sq in.

The results of some experiments with an 8-in. speaker are shown in the two graphs on these pages. Note that in each the speaker's free-air resonance occurred at 74 Hz. First a straight $\lambda/4$ pipe was built, the speaker installed, and an impedance curve run. The curve is similar to that of a bass reflex enclosure tuned to the speaker's free-air resonance. This is not surprising since both types of boxes offer maximum damping at resonance.

Next, the $\lambda/4$ pipe was loosely stuffed with fiberglass. Note that the new impedance curve is much flatter with a single peak at about the original free-air resonance point. It seems that for this particular combination of speaker, pipe, and stuffing, the system's impedance behavior is similar to that of a closed-box system—with one big exception. Instead of the enclosure raising the resonant frequency, resonance is back to where it was in free air. This combination should provide good response down to the speaker's resonant frequency, although too much stuffing could produce excessive bass rolloff at that point.

The speaker was then installed in a pipe of about twice the length of the first one and another impedance curve was run. Finally, the longer pipe was loosely stuffed and another test was run. The results of this combination yielded the flattest impedance curve of all tests.

The stuffing used for the tests consisted of house insulation grade fiberglass which was ripped from its backing sheet to leave a rough absorptive surface. An alternate method is to cut the fiberglass into angular wedges so that they fit together loosely.

For those who wish to experiment with the labyrinth enclosure, the suggestions of various manufacturers on which of their speakers might be suitable are given in the table opposite. ◈

ANY HOBBYIST who has ever worked with integrated circuits and other miniature components knows that the printed circuit board offers the only realistic approach to assembling a project containing these devices. Traditional point-to-point wiring is clumsy, inefficient, unsightly, and potentially dangerous to the new breed of delicate components used by hobbyists.

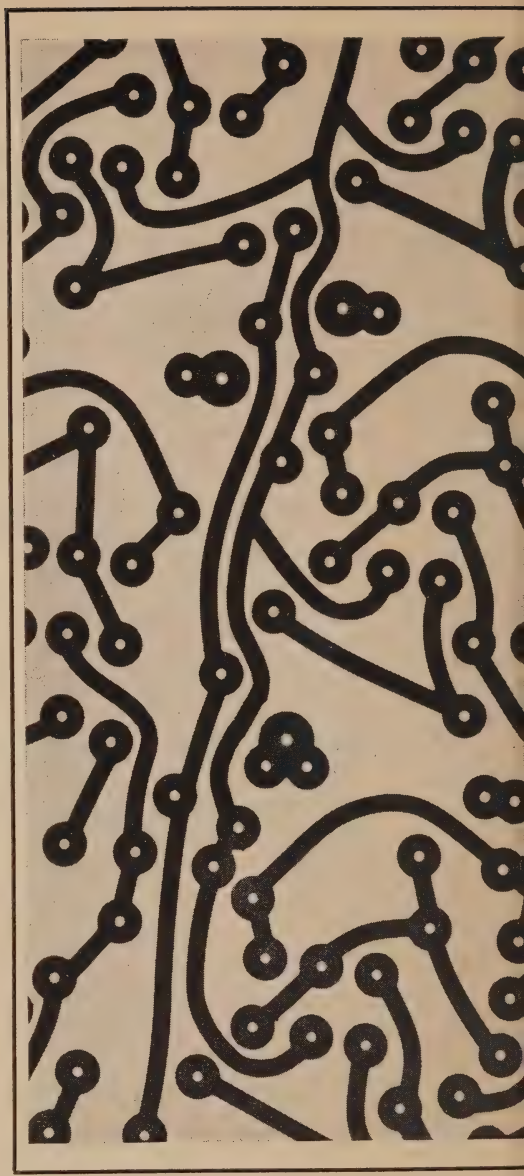
Yet, until a few years ago, materials for making printed circuit boards in the home workshop were difficult to come by. Often, materials had to be bought piecemeal; etchant here, board blank there, and resist another place. Some experimenters were very ingenious in their searches. Resist, usually the most difficult material to come by, took many forms, from nail enamel to China markers. Needless to say, results were crude.

In just three years, the situation in PC board materials has changed drastically. Now, every major mail-order house and most local electronic parts dealers are stocking a full line of PC materials, including kits. One need only order from a catalog or pick off a shelf anything he might need to fabricate any type of PC board in his home workshop.

The printed circuit kit offers the hobbyist his best dollar value. Here, the purchaser receives several items which, if bought separately, would undoubtedly cost him considerably more than the asking price of the kit. For the avid hobbyist who makes many projects a year, on the other hand, considerably greater savings can be effected if materials are bought in quantity—etchant in gallon and five-gallon bottles, large board blanks instead of several small ones, etc.

In the kit area, there are many offerings. The most basic PC kits contain at least one or more board blanks, one or more of several types of resist, etchant for removing from the board unwanted copper, and an etching tray which is usually the plastic tray in which the kit is packaged. In addition, some basic kits include one or more of the following items: resist remover, board cleaner, small drill, design paper, stencil cutter, etc.

In classifying a PC kit as "basic," we refer to the finished printed circuit board which it is capable of producing and not its price (although most maufacturers price their kits accordingly). Hence, our term "basic" refers to the fact that such a kit is primarily intended for the beginner and the hobbyist whose interests lean towards simple, non-critical projects.



A basic kit will yield varying results, according to the experience of the user. Working only with the materials provided in the kit, most non-IC projects should present no difficulties. The projects using IC's —especially the DIP's, or dual in-line packages—will require some talent in translating the original design into a usable printed circuit board on which the closely spaced conductors and solder pads nearly touch.

A LOOK AT THE PC MARKET

KITS AND BASIC MATERIALS SIMPLIFY MAKING PRINTED CIRCUIT BOARDS AT HOME

BY ALEXANDER W. BURAWA

Generally speaking, the basic printed circuit board kit (containing those items mentioned above) will provide excellent results every time if its limited materials are not taxed. The suggestion here is that if you plan to work with IC's and other components that demand more rigid control over the etching and drilling steps, it is better to move up to one of the so-called "lab" PC kits that are designed to cope with more precise demands.

As far as we have been able to determine, most printed circuit board kits fall into either the basic or the lab category with only one in the intemediate category. There is, however, no disadvantage to this step adopted by the industry since even intermediate hobbyist projects tend to take advantage of a potpourri of solid-state devices, including IC's.

Although not all lab-type kits contain the same list of materials, there are certain items that are common to all of them. Among the standard items are various sizes and types of board blanks (clad on one or both sides, employing phenolic or epoxy-glass bases, photo-sensitized and unsensitized, and perforated and blank), etchant resists (usually a combination of the various types available), and etchant. While the list so far resembles that of the basic kit, the lab-type kit contains considerably more of each item. Then there are the other items in the kit which are designed to assure professional results.

Almost without exception, the lab-type PC kit features a dual-resist system. The primary system is based on a photographic technique in which a foil pattern "negative" is used to "expose" the photo-sensitized board. The negative itself is made from materials supplied, or it can be carefully drawn on a white background with India ink and submitted to a professional photographer to be make into a film negative. The latter approach, of course, will yield the best results and allow for finer detail.

In most cases, the exposing medium in an intense white light source or a medium-wave ultra-violet source (for the former, most kits also supply a photo-flood lamp). To prevent the negative from slipping around during exposure, and to keep it flat against the board blank, most kits also contain a plate glass sheet or jig that is used to clamp the two together.

Once the board has been exposed, it must be immersed in a developing solution (also supplied) to remove the resist over the areas of the board where you want to etch away the copper. Then the board, after rinsing in water, goes into the etching solution where it is converted from a blank to a PC card ready for drilling.

For unsensitized blanks and sensitized blanks which have accidentally been exposed (and thoroughly cleaned of photo-resist), conventional hand-apply resist can be used for making the PC board. Most kits supply more than enough of the hand-apply resist

Circuit-Stik's "Quik-Circuits" employ foil conductors on plastic laminates and perforated boards to take the mess out of designing PC boards.

materials to take care of just about any contingency.

The etched and cleaned PC card can be given a professional appearance by immersing it in a tin-plating bath. The tin covers only the exposed copper, facilitating easy soldering and sealing the copper against oxidation.

One more PC kit is worthy of mention here, although its appeal is mainly to the hobbyist who has to make multiple runs of a single type of board. This kit employs a silk-screen technique that can provide almost as fine a detail as is obtainable with the film-negative technique. All materials for making the silk screen master are supplied.

In the non-etch category, there are at present only two types of kits available. In one, a combination of different types of perforated boards are employed, one of which has a series of parallel strips of copper foil on one side. The foil can be easily cut to form the PC pattern. A special tool, supplied with the kit, is used for cutting the foil.

Printed circuit boards made with the parallel conductor pattern must be laid out to take full advantage of the hole matrix and foil strip orientation. And, although this type of kit was designed primarily for use in breadboarding and setting up original circuit prototypes to serve as models prior to industrial production runs, the carefully designed printed circuit board made at home can serve equally well as the finished product in a project.

The second type of kit also employs per-

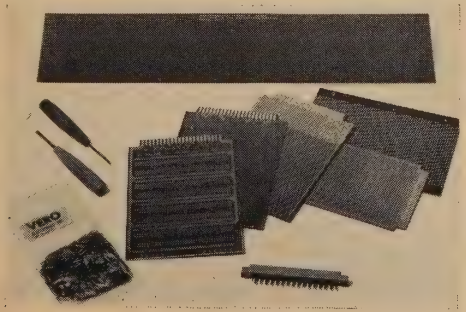
Typical of Kepro kits are pyrex glass etching trays. Photosensitized board blanks are packaged in opaque plastic sleeves. Other materials in kit are etching and developing solutions, photo-flood and safe lights, design items.

Called an "Industrial Laboratory," Techniques' kit includes everything needed for turning out first-rate printed circuit boards. Included in the well-rounded kit are a small drill, exposure jig (top left), and tube and transistor sockets. Both phenolic and epoxy-fiberglass base board blanks are supplied.

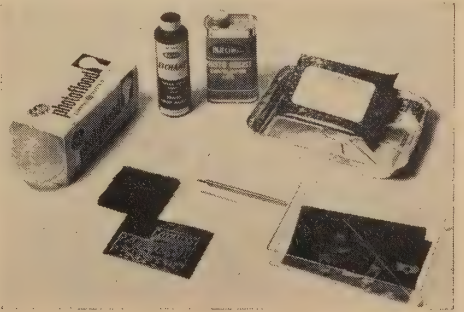
forated boards (none with copper conductors on it). Different configurations of solder pads on heat-resistant laminates and copper foil, both adhesive-backed, are used in making up the printed circuit pattern. The adhesive is a special formulation that resists breakdown under normal soldering temperatures, and the laminate on which the soldering pads are deposited will resist even higher temperatures of operation.

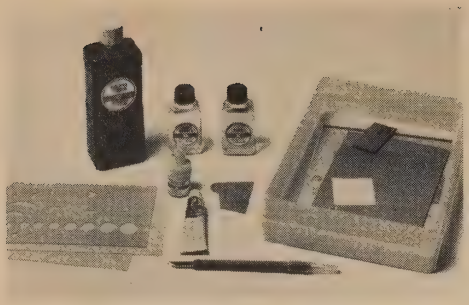
There is a considerable variety of paste-down solder pads available, including those for 6-, 8-, 10-, and 12-lead round IC's 14- and 16-pin dual in-line (DIP) IC's, flat packs, 3- and 4-lead signal and low-power transistors, tag-strip layouts, multiple-lead connection points, etc. To further simplify matters, the hole locations on the pads mate

Vero's non-etch kits employ perforated boards with copper foil strips. Special foil cutter and push-in solder terminal insertion tools included.



Injectorall photo-resist kit contains usual materials plus test negative, stencil knife, cleaning pad. Clips and glass are exposure jig.





Eico kit is unique; it employs enamel resist (in tube), and includes design template, materials for removing enamel, and cleaning board.

exactly with the hole matrix on the perforated boards. And, since the foil and solder pads are adhesive-backed, any mistakes made in the layout can be quickly rectified.

Design and Layout Aids. When making up your shopping list, include a few items (available from most stationary or art supply stores) that will simplify the design and layout tasks. Include graph paper with ten divisions/inch, tracing paper (vellum is best), clear sheet acetate, soft-lead pencils, and india ink and pen for the design end. For actual layout work, add opaque flexible tape in several narrow widths, amberlith sheets, a dry-transfer lettering kit, and a hobby knife.

If you want really professional photographic-quality negatives for exposing sensitized board blanks, look into the drafting aids avaliable at art supply stores and from some of the mailorder electronics houses. These items are fairly expensive but well worth the investment if you are planning to make multiple runs or require precise control of the PC foil pattern.

Example of Vector photoresist kit shows etching crystals (lower left), rub-on resist patterns, burnisher, design materials, and board blanks.

Directly from the electronics supply houses, you can get nibbling tools for cutting boards to size, PC board repair kits, board blanks, etchant, all types of resist, sockets, etc. And make a trip to your hardware store to pick up several small-diameter drills.

After working with PC boards for a while, you will realize that you no longer have to depend on commercial sources of boards to complete a project. With a little practice, you will be turning out boards every bit as good as those made by industrial techniques —and you will save a lot of money in the bargain. ◈

SUPPLIERS OF PC KITS AND MATERIALS

Calectro: Basic kits and materials; photo-resist not used.

Circuit-Stik: Sold under name of "Quick-Circuits." Kits and materials; non-etch system employs perforated board and solder pads on heat-resistant laminates; suitable for all levels of work.

Eico: Basic kits; use enamel resist exclusively; include stencil knife, paint remover, design template, board cleaner.

Injectorall: Basic kits employ tape-and-dot resist; intermediate kits have photo-resist and include photo-flood lamp.

Kepro: All levels of kits, all types of resist. Nameplate and panel kits; silk-screen kit; individual PC materials available separately; advanced kits can be used in critical designs.

Techniques: All levels of kits; silk screen kit.

Vero: Industrial design PC kits employing non-etch system and separate items available; based on parallel conductors on perforated boards; can be used for all levels of work.

Dynachem Corp.: Aerosol photo-resist; developer; aerosol dye for photographic process in making PC boards; available in starter kit or separately.

Vector: All levels of kits; employ photo-resist; dry-transfer resist, and tape-and-dot resist; etchant comes as crystals to be mixed with water; suitable for all types of PC work.

Army Buys Tactical Landing System

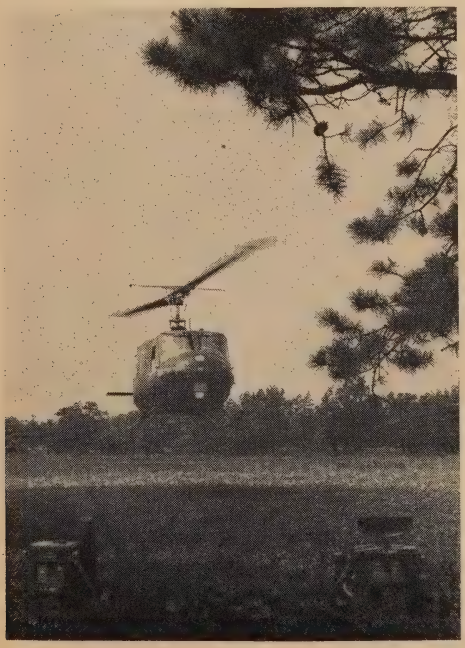
THE U.S. Army Electronics Command, Fort Monmouth, N.J., has awarded Cutler-Hammer's AIL Division a $4.8 million contract for the development and fabrication of a Tactical Landing System (TLS).

The small, easily transportable TLS system (shown here) can be set up in a matter of minutes at any landing site large enough to accommodate helicopters. The units transmit scanning flat microwave fan beams that sweep through a sector of 60° and provide proportional precision azimuth (steering) guidance information in the form of coded signals uniformly distributed over the coverage. During a separate time slot, but on the identical frequency, the glideslope beam sweeps vertically through an angular sector of 20° above the horizon. A third time slot is used for DME (distance measuring equipment) by the aircraft. This latter part is optional.

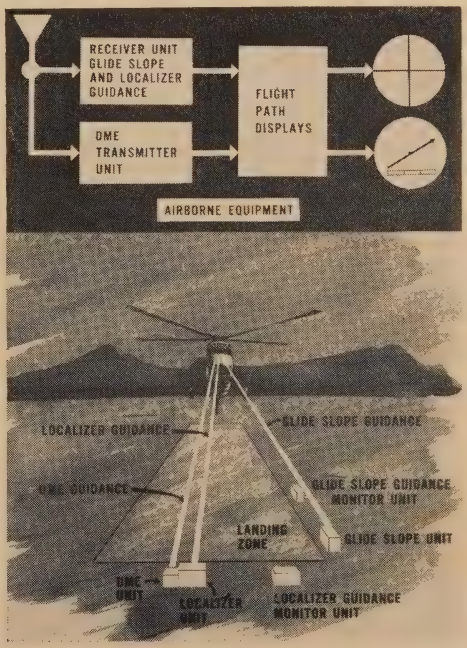
The overall system is to be used when the landing site is obscured by clouds or darkness.

The Army UH-1D helicopter is shown (below left) using the A-SCAN (prototype) during landing tests at Lakehurst Naval Air Station, N.J. The diagram and pictorialization at right show the functional concept of the TLC, which uses Ku-band frequencies. ◈

The helicopter landing system shown here is A-SCAN, predecessor of the new Tactical Landing System which is to be developed by Cutler-Hammer's AIL Division. A-SCAN was used as a laboratory tool in conducting live flight research into the steep, helicopter instrument approach problem.



The ground-based TLS system will use microwave scanning beams to provide approaching Army helicopters and/or fixed-wing aircraft with complete position coordinates by interpreting the coordinates in terms of approach path deviations, distance to go, distance rate and height of the aircraft.



Communications Scene

By Richard Humphrey

INCENTIVE LICENSING FOR HAMS: PROGRESS OR DISCRIMINATION?

THE PURPOSE of incentive licensing for hams, so we were told, was to advance the state of the art by dangling a "special privileges" carrot before our noses. The Advanced and Extra class licensees now have radio rights where Generals and Conditionals "shall not tread"—which keeps the lowly out of their hair. But have you noticed any advance in the state of the art or do you just get the feeling that nothing has changed?

The bulk of ham activity is on 80, 40 and 20 meters, three bands which have been in existence for nearly 50 years. And these three bands are among those that have special segments set aside to tempt us to better ourselves. At one time, hams were as militant, mangy, arrogant a bunch of soreheads as could be found anywhere in America, but now we're even having trouble being incensed over incentive licensing. And considering everything, I think we should be.

It's not that incentive licensing, *per se*, is bad. It's just that this latest effort seems to be a symptom of some vague malady rather than a step forward. We have been called "ingenious", "resourceful", and "contributors to the electronic arts". But not lately.

In his excellent book, *Two Hundred Meters and Down; The Story of Amateur Radio* (American Radio Relay League, $1), Clinton B. DeSoto tells of a seventeen-year-old boy in 1920 who had one of the better stations on the air. The amazing thing is that this boy had built everything in his all-homebrew station even to the headphones and tubes!

In the decade before the passage of the Alexander Bill in 1912 (which brought licensing, the 1000-watt power limit, and the first crude frequency allocation), it has been estimated that 75% of all radio stations on the air were amateur stations. They were, for the most part, stronger and better stations than the military or the commercial stations had.

When the Alexander Bill put the hams on 200 meters (considered by experts of the day to be ridiculously high and good for nothing but short-range communications), it didn't take the hams long to find out that these frequencies were capable of distances unheard of on the lower frequencies. After World War I, 100 meters became the thing. The first transatlantic contacts in the early 1920's were made on 100 meters. Then came the North Pole QSO's. Radio in the 20's was the national hobby. The average man had no trouble following the simple schematics of the day and assembling his own gear. The amateur was regarded with awe.

Once before in these pages it was suggested that the *status quo* of amateur radio had become too "status" (POPULAR ELECTRONICS, March 1969). Admittedly we're all human enough to want an "exclusive" hobby. To have people's eyes glaze in adoration and wonder at the magnificence of this enigmatic creature, the radio amateur, as he walks with simple majesty through their midst. But is a 25-kHz high-rent "Knob Hill" on a few amateur bands the way to do it? So who's impressed?

A year or so ago I talked to many people trying to discover some interesting and exciting amateur activities. One official-type amateur told me that "having your own radio station is exciting enough for anybody." This, in a day when there are over 800,000 CB'ers, 200,000 pleasure

boats equipped with radiotelephones, and Lord knows how many taxicabs, pizza parlors, air conditioning service organizations, auto parts dealers and so-forth using two-way radio. And most of them for many more hours a day than even the most avid ham. No, the bloom is off the rose. It's no longer exciting or significant or productive to be doing the same thing today that we've been doing for almost 70 years.

Perhaps—because we are so adept at "self-policing"—we should make a collective effort to try again to raise ourselves by our own bootstraps. It's painfully obvious that the 25-kHz carrot hasn't worked.

Here is what is admittedly an outrageous thought: why not just three classes of licenses—Extra, General and Novice—with the examination for each remaining the same. General class would have full privileges on 80 through 10. The Novices would have expanded rights—possibly up to one-half of each band—on 80 through 10 with the existing power and license-term restrictions. The Conditional license would become a General class ticket. The operating rights of the two licenses are identical, aren't they? But to operate on 6 meters and up, you'd have to have an Extra class license. Consider this: where is the frontier of radio—and by that, I mean everything run by or dependent on radio frequency emission? Is it on 80 through 10? Or VHF-and-up? Where is technical knowhow needed more? On 80 through 10 or in the field of microwaves?

The 80 through 10 bands should be a training ground for the beginner (the Novice) and a place to expand the knowledge of the General. When the life "down on the farm" begins to pall, the ambitious ham can go for his Extra class and on to "higher" things.

If proof is needed that the future of radio and the radio amateur is in the VHF-and-up portions of the spectrum, count the number of companies which formerly made equipment for 80 through 10 that either (a) no longer make that equipment (or have sharply curtailed their line) or (b) have gone out of business.

One of the most intriguing developments in recent years is the two-meter FM repeater craze that's sweeping the country. It would be difficult to estimate what classes of licensees are involved in this but among the scores of two-meter buffs I've talked to, only one was *not* a Technician. And the Technicians weren't even involved in the 80 through 10 incentive licensing brouhaha!

There's just too much open, undiscovered country up there in the VHF-and-up range not to become excited about it. What about voice-modulating a surplus radar? For that matter, has anyone considered experimenting with the so-called "river" radar or ASDE (Airfield Surface Detection Equipment) radar which operates in the 25,000 to 36,000-MHz region? At these frequencies, the actual shape of the target is displayed and not the "blip" seen on the CRT of lower-frequency radar. It could be just a step beyond to where "remote television"—actually being able to receive a "non-broadcast" picture from miles away—would be possible. It's certainly communications of a sort. And UHF, SHF and EHF is where it's at.

Item: Laboratory reports from here and abroad show that microwaves change the basic habits and learning patterns of laboratory animals. These frequencies seem to penetrate far deeper than the conventional diathermy waves. "We have observed," writes Dr. Alfred W. Richardson of Southern Illinois University, "disorientation, 'personality change', lethargy or hyperactivity depending on dosage . . ." The penetration into animals—and human beings—peaks around 900 to 1000 MHz. Ultrasonic frequencies have been reported to have similar effects. Consider combining the two: a microwave carrier *modulated with ultrasonic frequencies*. Take this one step further and modulate the ultrasonic frequency with audio frequencies to give what might be termed "double modulation" of a microwave carrier. If any of you begin to hear voices in your head, be sure to log them! And get the callsign!

These thoughts may seem outlandish. But don't forget that Lee DeForest had to endure the scolding of a judge in open court and just missed being convicted of fraud because he had claimed his Audion—the first triode tube—could send human voices through the air.

In brief: radio and the uses of radio frequency have expanded, explored, gone in all directions while many hams are still discussing audio quality and what tubes they have in the final. ◈

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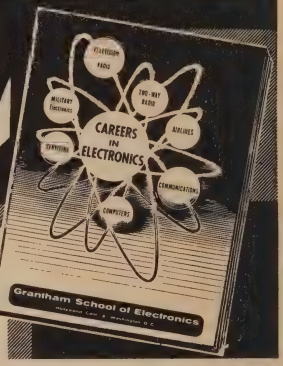

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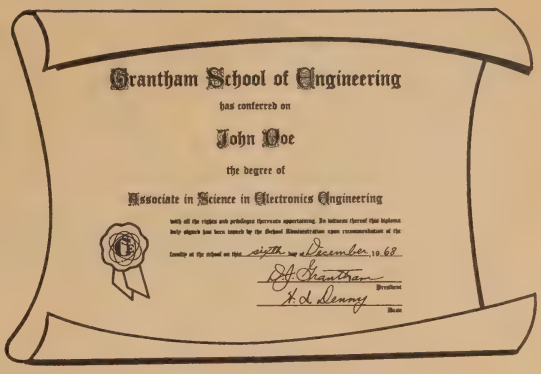
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CIRCLE NO. 18 ON READER SERVICE CARD

Transmitter for the Neglected Band

NO LICENSE IS REQUIRED FOR THE 1750-METER (160-190-kHz) BAND

BY JIM WHITE/W5LET

AS LONG AGO as 1950, the Federal Communications Commission issued Part 15 of its Rules—an action we are all familiar with because it legalized the operation of unlicensed walkie-talkies of the 100-mW class in the 27-MHz (11-meter) CB band. The same action also set up a 30-kHz band between 160 and 190 kHz. This relatively unknown, unused band can be utilized for experimental, unlicensed operation provided certain technical requirements are met. The latter include: transmitter input power must be limited to 1 watt; antenna and feedline length must not exceed 50 feet; emissions outside the band must be down at least 20 dB below the unmodulated carrier; and operation must be on a non-interference basis. There is also the universal rule: no profane or illegal language!

You may wonder what can be done at these low frequencies with only one watt. Here, the ground wave is the thing. On a cold winter night, with an efficient antenna, you can work up to 100 miles. There are no restrictions on the type of emission that can be used; so you can experiment with radioteletype, SSB, FM, conventional AM, or just plain CW—as long as you observe the band limits with your modulation and make sure that no commercial station is on the air in your location.

What do you do all this with? The gear described here is an easy-to-build, low-cost transmitter using only three tubes. (A companion tuner will be described next month.) The r-f portion of the transmitter (Fig. 1) uses a dual triode (*V1*), with one half used as the oscillator and the other half as the r-f amplifier. Crystals for this frequency are expensive and hard to find, but the oscillator circuit used here is very stable. Another dual triode (*V2*) is used as the speech amplifier with gain control between stages. These two stages provide ample gain for a ceramic or crystal mike. The speech amplifier drives *V3*, a class A modulator.

The power supply is a conventional half-wave rectifier with filter.

Construction. The prototype was assembled in a 7" x 9" x 2" aluminum chassis as shown in the photographs. Although the layout is not critical, it is suggested that the same general approach be used. Note that the transmitter coil *L2-L3* is on a plug-in

EDITOR'S NOTE

Although the transmitter described here does not require a license for operation, strictly speaking it may need a certificate attached to it. The certificate may be executed by "a technician skilled in making and interpreting the measurements that are required to assure compliance" with Part 15 of the FCC Rules. The certificate should contain information on the operating conditions of the device, the antenna being used, a statement certifying that the device complies with the FCC Rules as described in this article, and the date of construction.

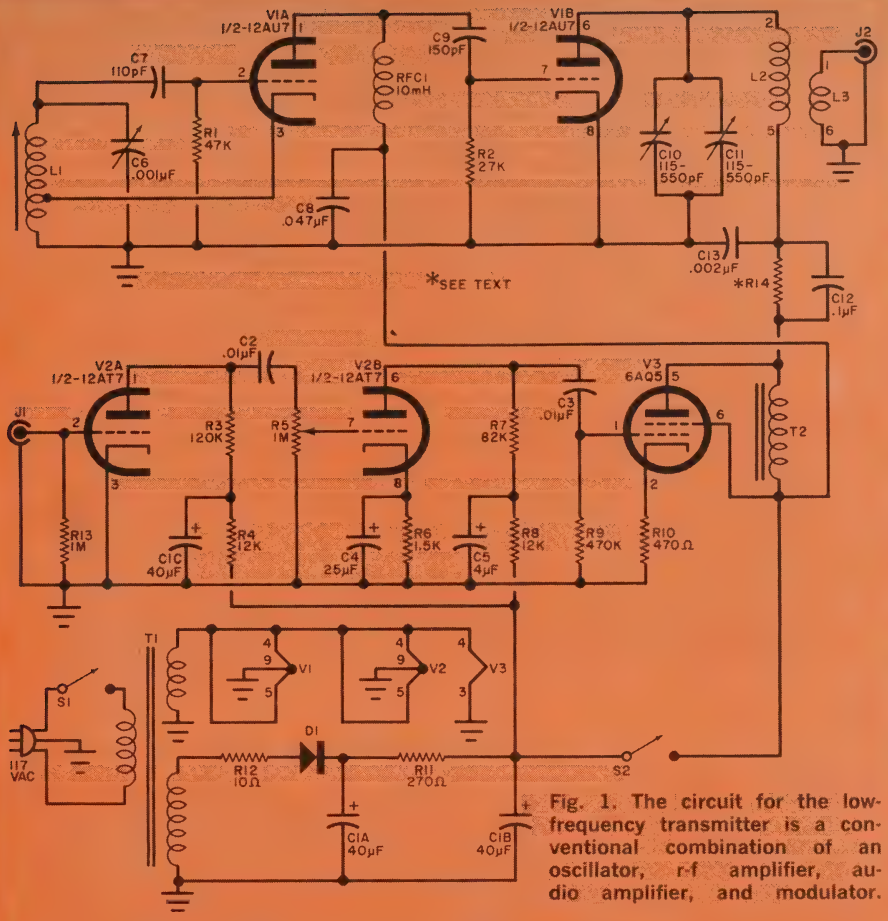
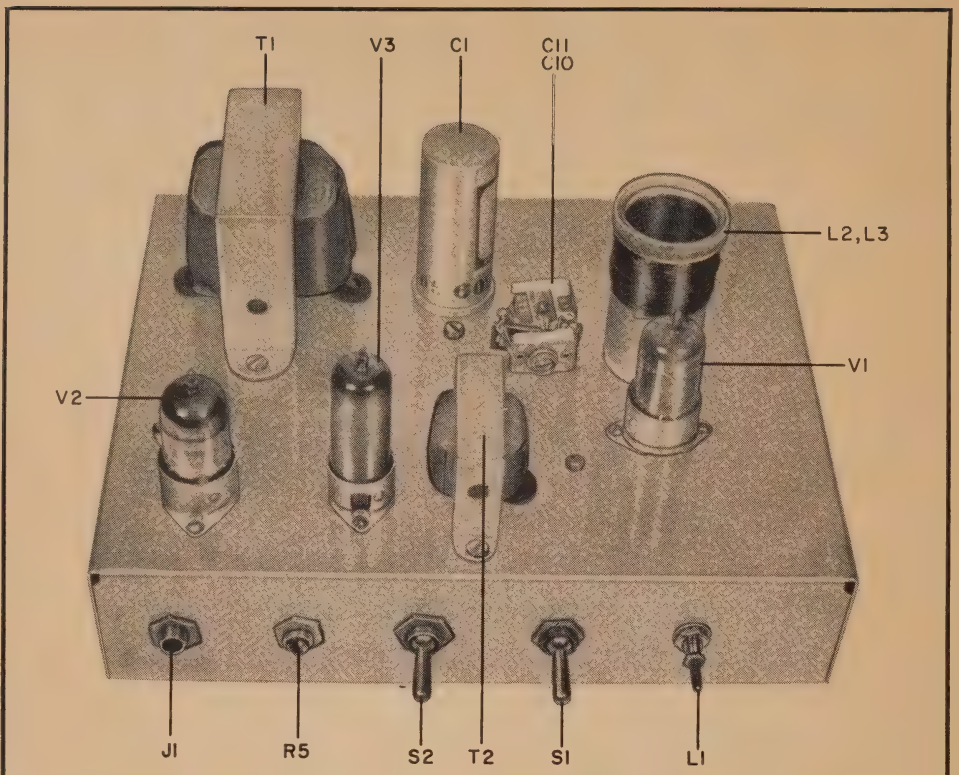


Fig. 1. The circuit for the low-frequency transmitter is a conventional combination of an oscillator, r-f amplifier, audio amplifier, and modulator.

PARTS LIST

C1—Three-section, 40-μF, 150-volt electrolytic capacitor
C2,C3—0.01-μF, 400-volt capacitor
C4—25-μF, 25-volt electrolytic capacitor
C5—4-μF, 150-volt electrolytic capacitor
C6—0.001-μF, 500-volt silver mica capacitor
C7—110-pF, 500-volt mica capacitor
C8—0.047-μF, 400-volt capacitor
C9—150-pF, 500-volt mica capacitor
C10,C11—115-550-pF trimmer capacitor
C12—0.1-μF, 400-volt capacitor
C13—0.002-μF, 500-volt disc capacitor
D1—Silicon rectifier
J1—Microphone jack
J2—Coaxial connector (Amphenol 83-1R or similar)
L1—Miller X-5496-C longwave tapped coil
L2—200 turns, #30 enamelled wire scramble wound on 1¼" diameter coil form
L3—25 turns, #30 wire, scramble wound on top of L2
R1—47,000-ohm, ½-watt resistor
R2—27,000-ohm, " "
R3—120,000-ohm, " "
R4,R8—1200-ohm, " "
R5—1-megohm potentiometer
R6—1500-ohm, ½-watt resistor
R7—82,000-ohm, " "
R9—470,000-ohm, " "
R10—470-ohm, 1-watt "
R11—270-ohm, " "
R12—10-ohm, " "
R13—1-megohm, ½-watt "
R14—See text
S1,S2—Spst slide or toggle switch
T1—Transformer; secondary, 125V at 50mA and 6.3V at 2A
T2—8-henry, 40mA choke
V1—12AU7
V2—12AT7
V3—6AQ5
Misc.—7" x 9" x 2" aluminum chassis (Bud AC-406 or similar), 7-prong tube socket, 6-prong tube socket, 9-pin tube socket (2), polystyrene coil form 2¾" long x 1¼" diam (Mayfair 24-6P or similar), terminal strips, rubber grommets, mounting hardware, short length of 52-ohm coaxial cable, antenna system (50 ft max for transmission line and antenna combined).



The components are easily assembled on a 7" x 9" x 2" aluminum chassis. Note how the L2 and L3 coils are random wound on the plug-in coil form.

form, so a socket must be used for it. The coaxial antenna connector, *J2*, is mounted on the rear apron. The oscillator coil, *L1*, is mounted on the front apron, with the tuning slug screw available from the front. The lead from *L3* to the coaxial connector is made from a length of small-diameter coaxial cable.

To wind *L2* and *L3*, use the form called for in the Parts List and drill four small holes over the designated pins to pass the wire through the form. The plate coil, wound first, starts at pin 5 of the form and consists of 200 turns of #30 enamelled wire, scramble-wound on the form. If you try to wind the coil neatly, you will soon run out of form, so scramble the windings to occupy about ⅞" of the form. Terminate *L2* at pin 2. Be sure to scrape the insulation off the wires before trying to solder them to the pins on the coil form.

Coupling coil *L3* is composed of 25 turns of #30 enamelled wire scramble-wound on top of *L2*. The winding begins at pin 1 and is in the same direction as *L2*. It ends at pin 6. Once the windings are complete, coat the assembly with coil dope to keep the turns from moving.

Testing. With power switch *S1* on and transmit switch *S2* off, note that the filaments of the three tubes glow. With *S2* on, check for high voltage at the tube plates. Take care when using the voltmeter—one hand holding the probe handle, the other off the chassis!

The best way to set the operating frequency is by using a frequency meter, remembering to include the sidebands and making sure that the entire signal is between 160 and 190 kHz. If you don't have a frequency meter, you can use an ordinary broadcast band radio. Select an operating frequency—say 185 kHz, which will have harmonics at 370, 555, 740, 925 kHz, etc. Choose a local station whose known frequency or its harmonic is the same as the

harmonic of your transmitter and adjust *L1* until the two beat against each other. To get enough signal injection, you may have to run the transmitter antenna lead close to the BCB radio antenna. Once the operating frequency has been located, the adjustment screw of *L1* can be secured with a drop of rubber cement or a jam nut.

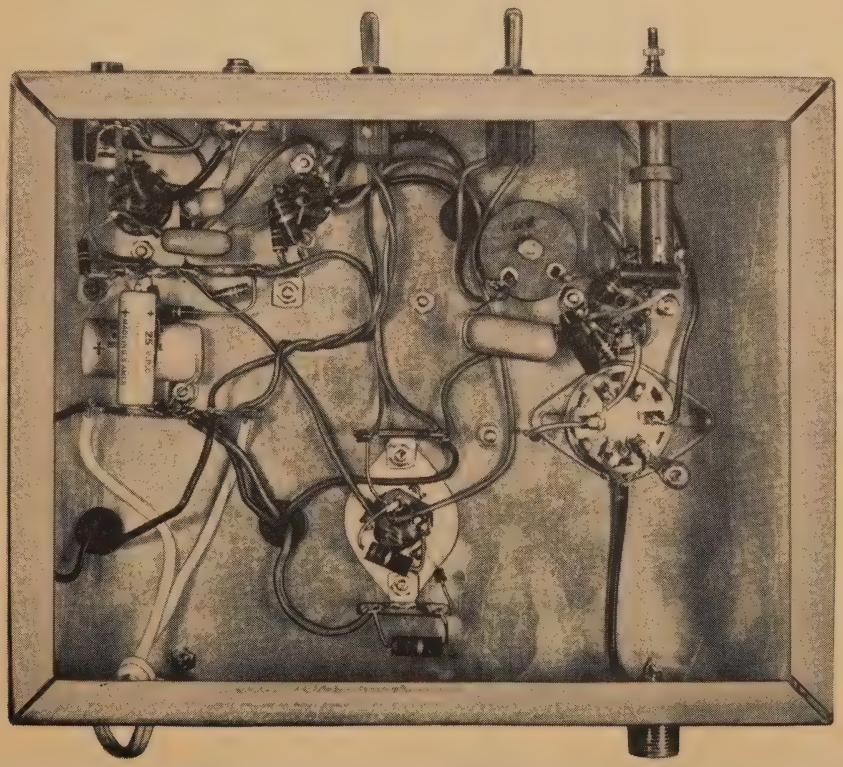
You can use a field strength meter to adjust *C10* and *C11* for maximum output, or you can connect a milliameter between *T2* and *L2* (for the moment, ignore *R14* and *C12* and tune *C10-C11* for a dip in plate current as the tuned circuit passes through resonance. With the antenna disconnected, this dip should be about 2 mA; and with an antenna connected, the current will be about 8 to 9 mA with *C10-C11* adjusted for minimum current.

To keep the operation legal, the power input to the final must be one watt or less. Measure the voltage at pin 5 of *L2*. If it is 120 volts, then you can run 8.3 mA final current (120 x 0.0083 = 1 watt). If the voltage is higher than 120, install *R14* bypassed by *C12* to reduce the voltage to 120. Resistor *R14* is determined (experimentally) by how much you have to lower the voltage.

Antenna. When you have only one watt of output power, the antenna becomes of paramount importance. A length of wire tossed out the window will not work. For best results, a vertical antenna should be used, with the total length of both transmission line and antenna not more than 50 feet. A good ground, preferably a series of long buried radials, must be used.

There are many all-wave receivers capable of tuning to the 160-to190-kHz band. If you have one of these, you can use it in conjunction with the transmitter to form a complete station. If you don't have one, you will be interested in the receiver which will be described here next month—a fixed-tuned superhet tuner designed specifically to be used with this transmitter. ◈

View of bottom of chassis shows how connections are made point-to-point with a liberal use of multi-lug terminal strips to support components.



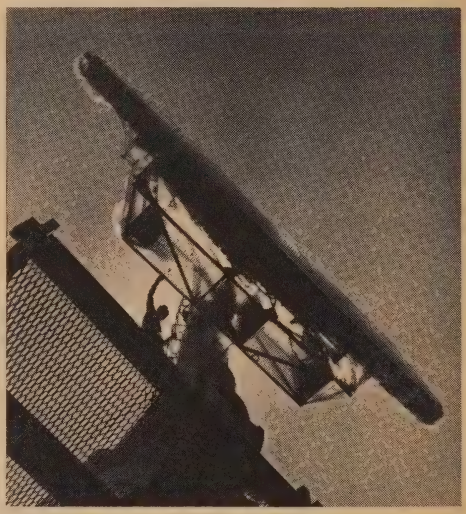
New Airborne Test Antenna

THE U.S. Air Force's Airborne Warning and Control System (AWACS) is designed to play a vital role in air defense and tactical command and control. It will use a three-dimensional radar capable of long-range detection and tracking of enemy aircraft through dense ground or sea clutter. This is accomplished by using a medium prf pulse Doppler radar featuring a planar array antenna with extremely low sidelobes. Monopulse and multiple elevation beams are used to achieve simultaneous three-dimensional search and track.

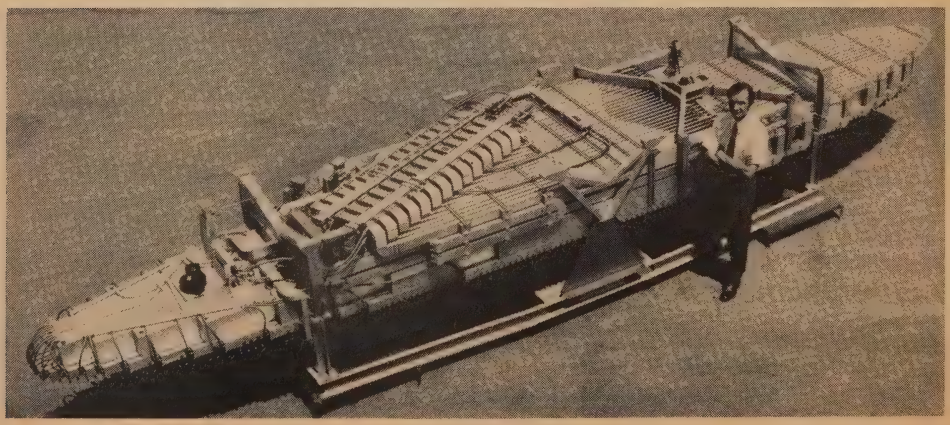
The photos on this page show the first airborne test antenna developed by the Hughes Aircraft Company. The picture at the right shows the prototype wrapped in protective plastic covering while undergoing pattern measurements at the Hughes Fullerton, California plant, prior to shipment to Boeing where it will be installed in a modified 707 jet.

To get the relatively large package to Boeing, it is disassembled as shown below. Looking like an abstract ship model, the component parts are mounted in a large shipping cradle, shown here being inspected by Hughes radar project engineer L. A. Burnett.

In the initial phase of the AWACS program, Boeing will test fly two different radar systems—one the Hughes system and the other designed by Westinghouse Electric Corp. At the end of the test stage, one of the radars will be selected for the operational system. ◈



Wrapped in protective plastic (right), the Hughes AWACS antenna runs through its pattern measurements. Before shipping to Boeing for airborne tests, disassembled antenna is securely cradled and inspected by engineer (below).



More Solid-State Electronics for the New Cars

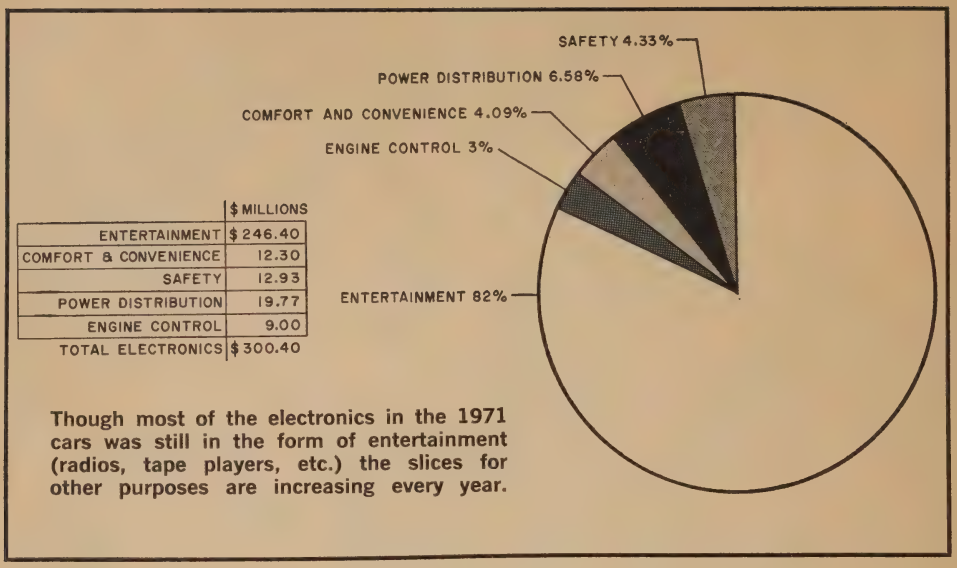
Here's what you'll find in the GM Line

BY JOHN D. DRUMMOND

SOLID-STATE ELECTRONICS has invaded the sacred precincts of the Detroit automotive scene. The family car will never be the same. There is a heated technical revolution under way that is rapidly changing both the complexion and complexity of the automobile. Your next car might be an electronics engineer's dream and a mechanic's nightmare as computers, "electronic brains" take over the control- and decision-making functions of the car.

Some of the goodies already in the works include computer-controlled anti-skid braking systems and transmissions; engines that never need tuning up; electronic fuel injection; etc. These are but a few of the electronic changes that will make your driving more pleasurable, safer, and less polluting.

Small Chip, Big Profits. Although Detroit's automen are understandably tight-lipped about their plans for the 1970's, semiconductor producers, the major promotors of automotive electronics, envision



	$ MILLIONS
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POWER DISTRIBUTION	19.77
ENGINE CONTROL	9.00
TOTAL ELECTRONICS	$ 300.40

Though most of the electronics in the 1971 cars was still in the form of entertainment (radios, tape players, etc.) the slices for other purposes are increasing every year.

have been dragging their feet in the change-over to solid state. Gerry Guillemaud, Engineering Manager of Texas Instruments Control Products Div., says, ". . . we can't get the automen to even share the same room with us. Until they do, further progress will be slow."

This feeling is shared by TI's Jack Kilby, inventor of the integrated circuit. Says Kilby, "Automen seem to go through a kind of heart rejection symptom whenever they are in the presence of electronics engineers."

A Motorola marketing manager puts it more mildly: "Detroit has never implemented a major design change that wasn't forced on it either by government regulations or by strong competition from European or Japanese car makers. The automen need EE's (electronics engineers) to work out their problems, but they're afraid to let us help them."

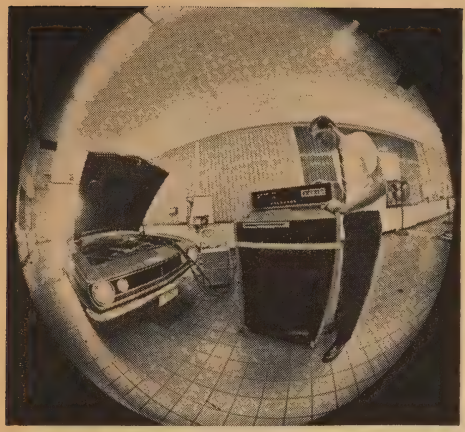
Obviously, the EE's cannot design electronic systems for the car without the cooperation of the automen. But getting that cooperation is easier said than done. The automen fear that in any joint venture, the EE will want to head up the project, placing the automen in a secondary—and totally unacceptable—role as the car maker. The upshot is that the auto makers, notably GM, are recruiting EE's to work with them in developing their own systems.

More Headaches. As electronics takes over the control and decision making functions of the car, mechanics are getting worried. They fear that they will have to undergo retraining or face their own obsolescence. Even now, there are very few auto mechanics trained to service the complex systems currently in use. It appears then that a new breed of specialists, electronics technicians with automotive training, will have to emerge in the near future.

By 1980, the automobile will have its own on-board checkout system that will allow the driver to periodically check out both his electronic gear and his car's engine. The anti-skid computer in the Lincoln Continental and Oldsmobile Toronado, the electronic speed control in GM and Ford cars, the computer that controls engine timing in fuel-injection-equipped Volkswagens, and the logic that runs the Toyota and Renault electronically controlled transmissions are essentially "black-box" devices that must be returned to the factory for servicing.

The difficulty now is in isolating electronic malfunctions from the associated mechanical links. To do this highly specialized job, computerized automotive centers are going to make a big impact in the service industry by 1980.

"The computer," says Don Muller, President of Universal Teleproducts, Inc., supplier of computerized testing systems, "is more reliable than conventional diagnostic capability which relies heavily on skilled judgment for accuracy. The computerized system substitutes microelectronic circuitry



Service technician runs a series of card-programmed performance tests with an Allen automotive diagnostic computer. Results are transmitted by computer printout to owner in lounge.

a big market in Detroit. They predict that the big push will be in the extended use of IC's. This, in turn, will result in electronics taking over more complex jobs in the car's command and control systems.

Increased use of electronics in the car will be due only in part to its ability to perform old tasks better. But the biggest contributing factor is that electronics can perform radically new functions that were impossible to contemplate in the era preceding the semiconductor. "The question is not whether the automobile will see increased use of electronics," says General Motors President Edward Cole. "It is rather a question of how soon."

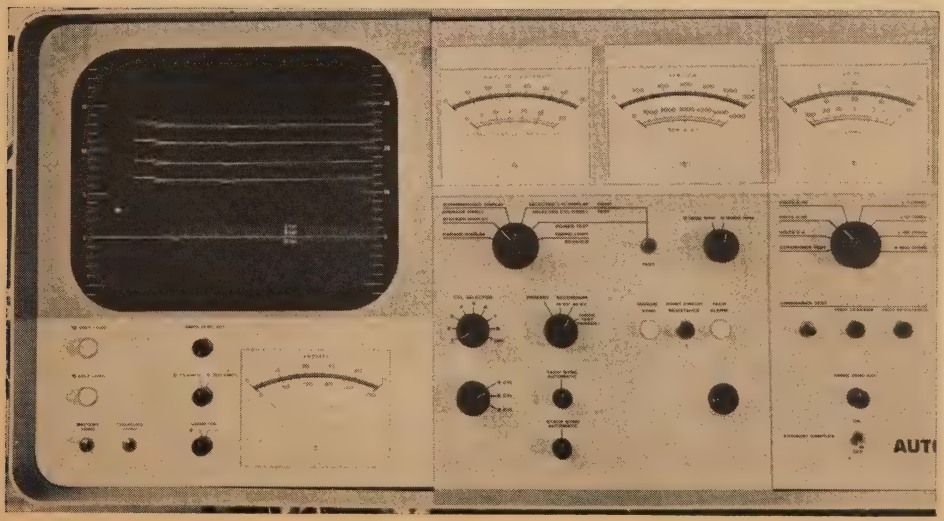
Anticipating the boom, major semiconductor manufacturers like Texas Instruments and Motorola have set up departments devoted exclusively to development and sale of automotive electronic products. And such automotive equipment specialists as Delco Electronics, Philco-Ford, and Bendix Corp. are also going full steam ahead with their own development programs.

John Welty, Vice President and Director of Operations for Motorola's Automotive Products Div., estimates that in this decade each car will be equipped with $100 worth, at factory cost, of electronic gear. The auto industry's own estimate that 15-million cars will be sold annually by 1980 means that the electronics industry will rake in $1.5 billion from the auto industry alone, making it second only to the computer industry as a source of revenue.

The dollar value of electronic equipment that will be sold to the auto industry just this year will exceed $300 million, according to the best available estimates (for a breakdown, see the chart opposite.)

Crossroads. In spite of the inroads already made, circuit designers in the semiconductor industry claim that the automen

Oscilloscope on electronic console used in Volkswagen Diagnosis and Maintenance System provides visual check of engine performance. Included are tachometer, voltmeter, battery tester, ammeter, stroboscopic light, dwell and advance meters.



for human skills. This reduces the margin of error, standardizing results and making the tests easier and faster for the average operator to perform."

Solid State On The Go. Automotive experts state that the only practical ways to reduce auto pollution are to improve engine combustion efficiency and to optimize disposal of the remaining waste products. Accurate control of the air/fuel ratio as a means of reducing exhaust pollution is actively being pursued by the automakers who are taking a long hard look at electronic fuel injection.

Based on performance experience with an electronic fuel injection system in the series 1600 VW, engineers at Bendix say that they have devised an approach that reduces hydrocarbon, carbon-monoxide, and nitrogen oxide pollutants by more than 15 percent through better fuel management in US-made cars. The system senses fuel demand and environmental and engine conditions, and uses this data to control fuel delivery to each cylinder.

The system is built with discrete components, but several IC prototypes are in the works. Predictions are that GM will offer its own injection system late this year with Ford following as early as next year.

An exhaust emission control device, called Combination Emission Control Valve and made by Delco-Remy Div., is also being used in all GM 1972 cars with the possible exception of Chevy's Vega. It performs all of the transmission-control spark plug valve functions in current GM engines and holds the throttle idle during third-gear operation.

Designed to help meet the exhaust emission standards that will go into effect in 1975, the system basically disposes of nitrogen oxides at the higher combustion temperatures. Electronically controlled, the Valve makes possible lower idle speeds under urban traffic conditions. Improved fuel economy is a serendipitous byproduct.

Another device that motorists will be using is adaptive braking for skid control. First used in the Lincoln Continental and Thunderbird, an anti-skid braking system is now an optional item on some Cadillacs and Oldsmobiles. Actuated by an on-board electronic computer, the system automatically pumps the rear brakes and prevents skidding during emergency braking on wet, slippery, or icy roads. An improved system that controls both front and rear brakes will be out next year.

The anti-skid braking system is used to overcome the dangers on slippery roads where friction between the tire and road may fall below the level required to maintain traction—especially if the wheels are suddenly locked by panic braking.

An electronic cruise control device that lets you maintain a constant preset speed on turnpikes—up or down hill—is also offered by GM.

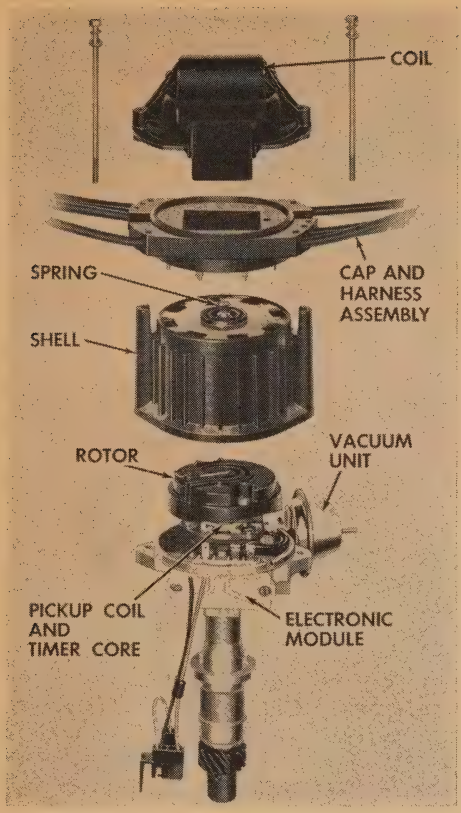
For more than three years now, GM has been testing one design for an electronically controlled transmission, and insiders are betting that it will appear in a Cadillac in late 1972 or in 1973 at the latest. But GM won't be first here; Renault is already using it on the Model 16, and Toyota Motor Car Co. of Japan has already announced a model with an electronically controlled transmission.

GM's Pitch. Ever since they introduced automatic headlight dimming in 1952, GM has compiled an impressive list of credits. And they are still at it. For example, Pontiac Div. has introduced a unitized ignition that will become standard on the Grand Prix SJ and optional on the Grand Ville and Grand Safari with a 455 cu. in., 4-barrel engine.

The system eliminates the conventional breaker points and capacitor and reduces the number of connections that have to be made to the engine. It is mounted on the engine and timed in the conventional manner but requires only one electrical connection to the distributor and one each to the eight spark plugs (down to 9 from 21).

The breaker points in a conventional ignition system must be serviced and periodically replaced to maintain good engine performance. But the unitized ignition system substitutes a maintenance-free built-in magnetic pulse generator and an IC electronic circuit. "A major advantage of this unit is that the need for electrical maintenance and tuneups has been eliminated, except for periodic replacements of spark plugs," states F. James McDonald, a GM Vice President and Pontiac's General Manager.

The unitized system provides more voltage for ignition during startup than can a conventional setup, and it maintains its voltage throughout the speed range, eliminating high-speed missing. This greatly extends spark plug life since the electronic



Pontiac's Unitized Ignition System combines distributor, coil, and spark-plug wiring harness into single maintenance-free unit. Points are replaced by built-in magnetic pulse generator and an electronic control using IC's.

circuit can fire fouled and dirty plugs much longer than can a standard system.

The combination of the unitized ignition system with lead-free gas will provide maintenance-free ignition performance for up to 50,000 miles for the average driver—so says a Delco-Remy Div. engineer.

Carefree Battery. A new sealed maintenance-free lead/acid battery is currently standard in the Pontiac Grand Prix SJ and optional in the Olds Toronado. Produced by Delco-Remy, the battery does not require the usual periodic checking and never requires refilling with water (there are no filler caps). Battery life should be appreciably extended because overfilling and underfilling are impossible. Contamination by common tap water is also a thing of the past.

The terminals are on the side instead of on the top of the battery. They are completely sealed in when the cables are attached. This eliminates corrosion build-ups caused by moisture, gases emitted through the battery's vent plugs, and electrolyte spillage. Moreover, the sealed construction reduces self-discharge when the battery sits idle for a long time.

With no corrosion, cable connections maintain their integrity to provide easier starting.

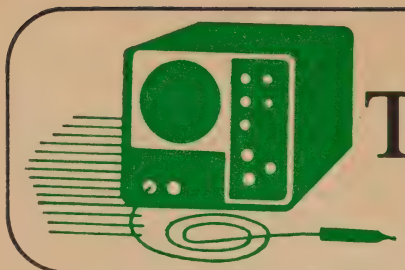
The division will also be offering the "most powerful charging system" ever used as standard equipment in passenger cars. The compact unit provides 80 amperes at normal speeds and up to 50 amperes at idle—more than enough to power all accessories while maintaining full battery charge.

The heart of the system is a built-in IC voltage regulator. "This system is another step in providing Pontiac owners with reliable performance under all conditions and relieving them of the responsibility of periodic maintenance," says GM's McDonald. Built by Delco-Remy, the regulator/generator was introduced in a limited series for the 1968 model year. Since then, it has undergone significant changes.

Electric Fuel Pump. An electric fuel pump which ties in with the fuel gauge in the gas tank will be standard equipment in Chevy's Vega and Buick's Riviera. The pump uses a motor-operated impeller to push the fuel from the gas tank into the carburetor in less time than it takes current systems, providing a quicker start after the car has been inoperative for a long time.

GM's engineers say that a further benefit of the electric fuel pump is a noticeable improvement in hot idle as well as an almost complete elimination of engine cutouts or sags in acceleration after the car has been standing or idling in a high-temperature environment. ◈

Editor's Note: Because of considerable reader interest in this topic, we have asked Author Drummond to prepare a second article covering additional uses of electronics in the new cars. This article will appear in an upcoming issue. Watch for it.



Test Equipment Scene

By Stan Prentiss

WHY TRIGGERED SWEEP OSCILLOSCOPES?

TEST EQUIPMENT manufacturers are "coming alive" at a remarkable rate And the biggest change next to new lines of sweep-marker and color-bar generators is an entire bevy of triggered sweep oscilloscopes. Following the "biggies" lead —Tektronix and Hewlett Packard—with their very expensive but highly accurate and durable equipment, such foreign and domestic companies as Telequipment, Leader, Sencore, B & K, Lectrotech, Heath, EICO, and others are now preparing to offer, or are offering, brand new dc amplifier triggered oscilloscopes that range in price from just over $300 to $975.

Comes the Evolution. Most of us hardly saw an oscilloscope before the very late 1940's or early '50's, and those we did see weren't exactly "instruments" as we know them today. Bandpasses were in the kilohertz range, as were X-axis sweeps, and hot vacuum tubes often made a blower fan necessary in the big units. Lower priced equipments were all ac-coupled and recurrent sweep types, with as few tubes as possible to keep down costs; and their linearity was often questionable. Since that time, there have certainly been refinements in these economical models, such as extended 5-MHz or 10-MHz bandwidths, recurrent sweep ranges to 500 kilohertz, perhaps dc amplifiers, and flat-faced cathode ray tubes. And these scopes are fine for general peak-to-peak voltage measurements and medium-to-low frequency waveform displays. But generally, many have not matured as have their more expensive brethren; once again, because of costs. There are still under $100-plus kit and $170-up factory-built oscilloscopes to be had, but you'll naturally have to make some allowances; because perfection forever costs money—all the way to thousands for the best.

What Is a Triggered Sweep? First, let us take a close look at a recurrent (non-triggered) sweep scope. Its sweep circuit consists of a selected timing capacitor charging up from a voltage source, and discharging through a tube or transistor. Because the charging curve of a capacitor is linear for only a short period, if the applied charging voltage is not on the head, the nonlinear portion of the charging curve is also included in the sweep. This same state of affairs can occur when you try to use a single capacitor over too wide a charging time to cover too much of a sweep range.

A recurrent sweep scope can be synced to a waveform, but because of wider manufacturing tolerances in low-priced instruments and the use of unregulated power supplies, the point where the timing capacitor starts and stops its operation may wander about a bit. Also, with a varying input signal, the scope sync circuit may have a little "play" so you have to expect some jitter in the trace.

What does a triggered sweep scope have that others do not? To start with, it usually uses some form of "lockout circuit" that unhitches the sweep circuit from the sync so that after the first toggle on, nothing coming in on the vertical channel can affect the stability of that particular sweep. This approach "dumps" the effect of variable sync due to noise and signal variations. Then, a triggered sweep scope uses only one selected capacitor for a limited range, and operates this capacitor well within

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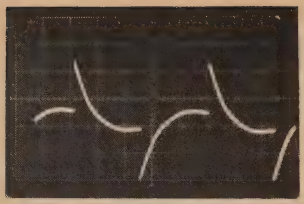
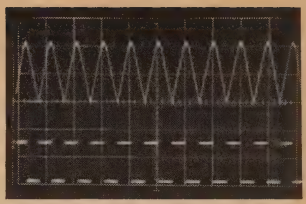




Three basic uses of an oscilloscope. Fig. 1 (left) shows measurement of peak-to-peak ac; Fig. 2 (center), dc voltage levels; Fig. 3 (right), frequency measurements.

its linear range. Also, most triggered sweep scopes use some form of well regulated power supply. All this costs money, and that is why they are more expensive than recurrent types.

What we'll do is supply a working introduction to a dual-trace triggered sweep oscilloscope, including a recurrent sweep scope for comparison.

Three Uses For An Oscilloscope. Let's start with the three basic uses of an oscilloscope. You can use it for peak-to-peak ac voltage measurements (Fig. 1); dc voltage measurements (Fig. 2); and time base-frequency measurements (Fig. 3). And the interesting part is that you can do all these things simultaneously. For instance the waveform in Fig 1 is simply a differentiated square wave. The vertical attenuator on the oscilloscope is set for 0.5 volt per division, but there is a 10X capacitance (LC) probe attached, so we move the decimal forward one place, and that makes each division worth 5 volts. Therefore, total peak-to-peak amplitude (height) of the waveform is 22 volts.

In Fig. 2, let's say that each division is worth 10 volts, and we'll establish a dc reference with the lower trace on the first (bottom) horizontal line of the graticule. So, if the voltage rises five divisions when the circuit is active, this means we're looking at a well-filtered power supply of 50 volts.

Time Base Measurements. Here, we'll use an exact function generator and different waveforms to illustrate what a triggered scope's accurately calibrated time base does. Let's set the upper channel for triangular waveforms and the lower channel for pulse waveforms (Fig. 3). Naturally, since the same time base is driving both, they're at the same repetition rate.

If you'd like to check the accuracy of both the oscilloscope and any calibrated generator you might be using, step up or down repetition rates so that just one division contains a complete cycle. In this instance (Fig. 3) we went to 0.1 millisecond per division on the scope's time base, and found, to our satisfaction that since $F = 1/T = 1/0.1 \times 10^{-3} = 10$ kHz. Note that the lower trace of Fig. 3 is a symmetrical, rectangular waveform with a 50% duty cycle, and this makes it a square wave. The upper trace is a sawtooth that is not quite linear at the top tip. Of course, while we're discussing oscilloscopes we're doing some waveform analysis that will be one of our more specific subjects in the future when we talk about graphic display instruments and their use.

An AC Recurrent Sweep Scope. To give an idea of what you might come across in the *lowest* priced equipment, let's do some waveform comparisons following a short explanation of what to expect. The recurrent sweep scope has a calibrated vertical amplifier that's as linear (current and voltage proportional) as the manufacturer can make it, for the price. Usually there's no dc amplifier, because these have to be especially biased and compensated and are more expensive to make. Then, of course, ther's no triggered sweep for time base measurements. So what you have is a peak-to-peak ac voltage indicator and a gross frequency horizontal sweep that's broadly readable from about 5 Hz to 100 or 500 kilohertz divided into X10 increments, with variable dc potentiometer tuning in between. And you must cope with a low frequency tilt.

What good are the inexpensive ac scopes? They're *excellent* for hobbyists, experimenters, some of the vacuum tube TV boys (where dc swings are too great to see ac signals except with capacitance coupled amplifiers), and those who have small pocketbooks and restricted needs. (Experienced TV and electronics people are now using dc-coupled amplifiers more

and more, especially in semiconductor work, where most dc levels and ac waveforms are simultaneously visible.)

Waveforms of An Inexpensive AC Scope. To illustrate what we've been talking about —at possibly, the most modest of levels —let's show the kind of responses that may be forthcoming if you select a real cheapie. Naturally, the better ac and the dc scopes do a more acceptable job than we'll show here—and this just might be a suggestion to evaluate before you buy.

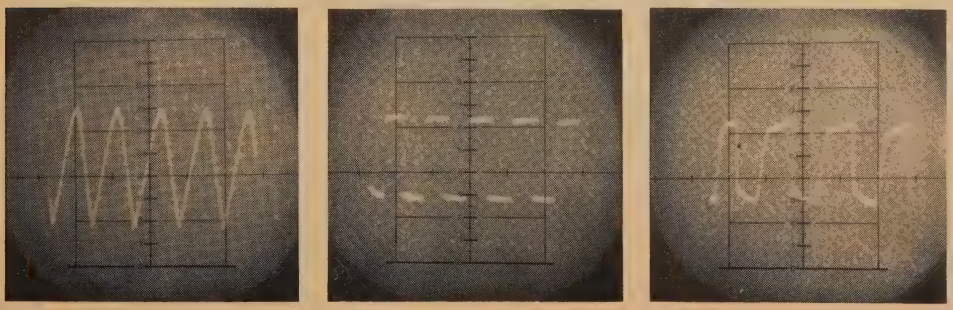
Fig. 4 is simply the top of Fig. 3 at the same frequency of 10 kilohertz, repeated on an uncalibrated X-axis of a recurrent sweep scope. Notice that the trace is thicker—has a much larger spot size, begins somewhat nonlinearly, and is somewhat out of calibration since the more expensive triggered scope measures 4.4 volts p-p, while this one (at 1 volt per minor division) is almost 5.4 volts—enough to make a substantial measurement difference in small-signal transistor circuits. Observe also that the trace thickens toward the right indicating poor stigmatism and focus circuits or adjustments, since they're interactive.

We'll switch now to the bottom waveform originally produced in Fig. 3 but reduce the repetition rate to 100 Hz as shown in Fig. 5. Here the rounding and tilted low frequency response becomes evident and the recurrent sweep seems to be somewhat other than linear since the duration of the initial left half cycle is less than the others. Vertical amplitude should be about 3 volts, and it indicates just over 4. Of course, this can be adjusted.

Let's go to a 1-MHz repetition rate. The recurrent scope won't hold frequency. So we'll drop down to 900 kHz and see what's cooking. Figure 6 shows the results, somewhat more plainly this time than at either 100 Hz or 10 kHz. The tilt again shows lack of low frequency response. The sloppy rise and fall times of each half cycle either indicate a poor generator—and this one isn't—or poor vertical rise and fall times in the oscilloscope's own amplifiers. The left initial trace is now quite nonlinear, although the Fig. 5 and Fig. 6 amplitudes remain the same. The tops of the 900-kHz pulses should be as flat as pancakes. This, of course, is why good pulse or square waves are usually used to check visual test equipment and all sorts of amplifiers. In the square wave, low frequency information is on the top of the waveform, and the intermediate and high frequency information is on the sides. Therefore, the more harmonics in any square wave, the steeper are its sides, and the more expensive visual instrument it takes to judge them correctly.

Final Considerations. Now, triggered or recurrent, take your pick, but look and ponder before that precious buck flies out the window. A little investigating can tell so much—especially with a good square wave generator. If your decision is ac routine, you spend (for a readybuilt) from $180 to $250; for dc deluxe or triggered sweep with single trace, the tag will be $340 to $450; and if you're considering dual trace, 5 or 10 millivolts sensitivity, and low nanosecond sweep speeds, $500 to $600 is the price you'll pay *plus* about $25 to $30 each for good probes. (Prices for scope kits in the intermediate range where available, are, of course, much lower.) But whatever you have or buy, learn to use it well—for an oscilloscope is every electronics man's best friend. ◈

Figure 4 (left) is the top of Fig. 3; Fig. 5 (center) is the bottom of Fig. 3; while Fig. 6 (right) is the same thing at lower frequency. All on a less expensive scope.



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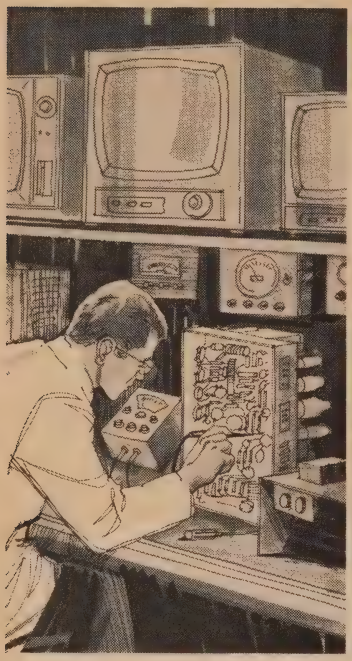

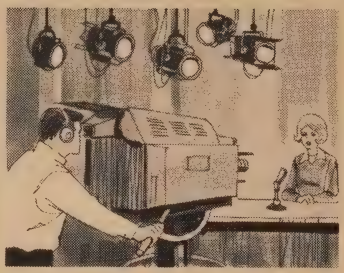

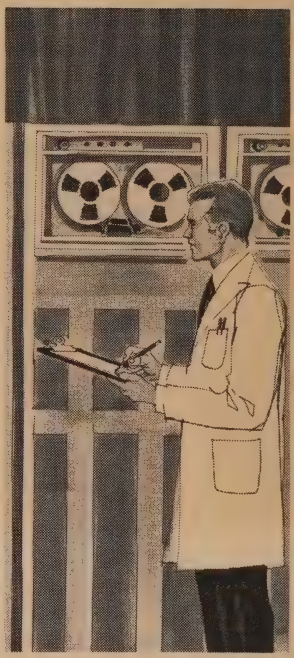

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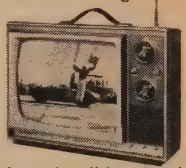

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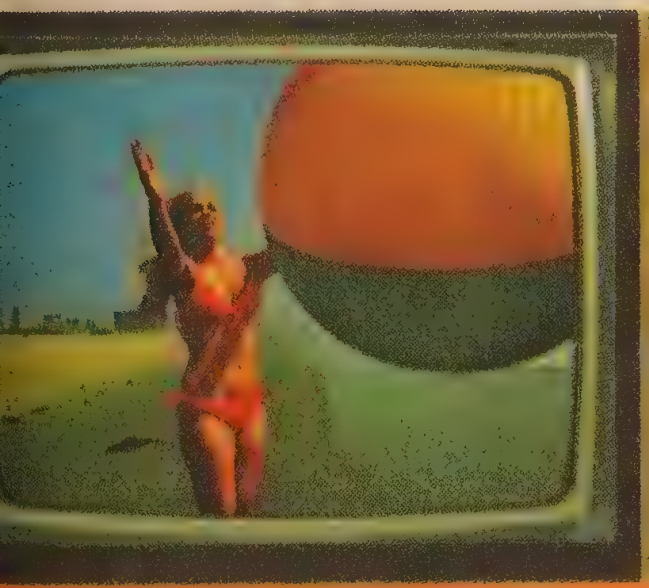

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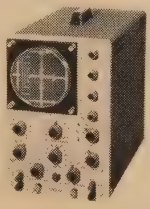

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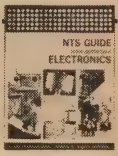

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Product Test Reports

LAFAYETTE RK-48 2/4-CHANNEL CARTRIDGE TAPE PLAYER (Hirsch-Houck Lab Report)

The millions of 8-track cartridges sold for use in automobile players have created a market for home cartridge players which make the automotive library useful in a home music system. Additional interest in the 8-track format has been generated by RCA's "Q-8" system of 4-channel cartridges. Like the 2-channel variety, these are useable in the home or in the car.

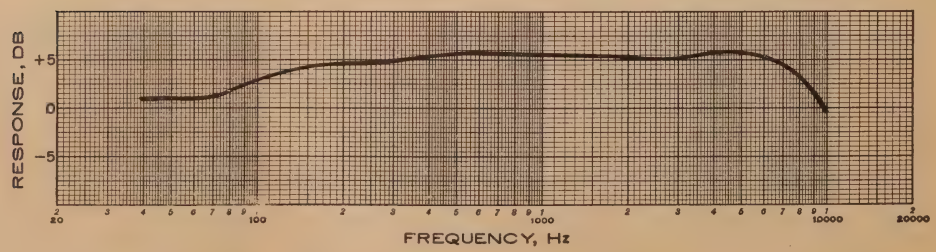
The Q-8 tape cartridge is essentially identical to the standard 8-track cartridge, except that the former contains two channels of 4-track stereo instead of four channels of 2-track stereo. The only external difference between the two is the keyed slot in the Q-8 cartridge. This slot automatically switches a suitably equipped player from the 2- to the 4-channel mode.

Description. The first 2/4-channel cartridge tape player to reach us for evaluation was the *Lafayette Radio Electronics, Inc.*, Model RK-48. This compact player, measuring 10½" x 9½" x 4⅜", has a minimum of user controls and is designed for playback only. It has automatic selection of either 2-channel or 4-channel cartridges.

There is no power switch for the operator to use; plugging the cartridge into the slot applies the power and removing the cartridge disconnects the power. A pushbutton to the left of the cartridge slot selects the 4-channel mode or the automatic switching mode (the latter requires a keyed cartridge). Lights above the cartridge slot indicate which type of cartridge is being played as well as the track (up to 4 for 2-channel and up to 2 for 4-channel cartridges). The player automatically advances to the next track when it has completed playing the endless tape loop. Manual selection of the track desired is possible by operating another pushbutton control to the right of the cartridge slot.

On the rear apron of the player there are four output jacks and a power fuse. There are no external level controls. With a 2-channel system, only the FRONT jacks are used. Connecting the REAR jacks to a second stereo amplifier or to the rear chan-

As shown here, frequency response of Lafayette Radio's RK-48 2/4-channel cartridge tape player is essentially flat from 100 to 10,000 Hz.



nel inputs of a 4-channel amplifier and adding a second pair of speaker systems completes the conversion to 4-channel listening.

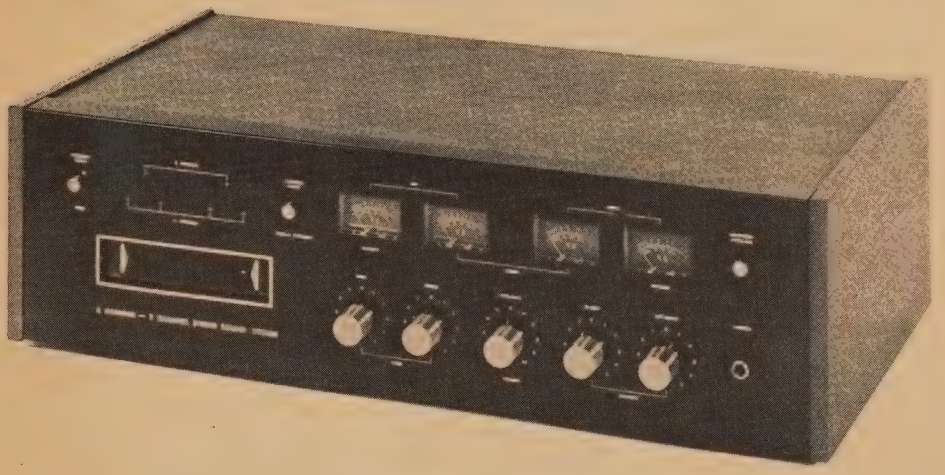
Test Results. Our laboratory tests of the RK-48 were limited to measuring its playback response with an Audiotex No. 30-213 test cartridge. The frequency response was +1/−5 dB from 40 to 10,000 Hz. The mid-range output level was about 1.0 volt, and the noise level was down 37 dB. Stereo crosstalk was below the noise level.

We listened to the RK-48 player with regular 8-track stereo cartridges and with the RCA Q-8 cartridges. It performed well mechanically, and the sound quality was typical of what we have come to expect from commercially recorded cartridges. The sound was satisfactory, although it was not up to the standards of reel-to-reel tape or even the better cassette tapes. This is apparently not the fault of the player. In our experience, cartridges tend to have a rather restricted frequency range and dynamic response—probably due to the high-speed duplication process rather than to the medium itself. Of course, in a car, these limitations are not apparent due to the masking provided by the high ambient noise level.

The Lafayette Radio Model RK-48 2/4-channel player sells for $79.95.

Circle No. 75 on Reader Service Card

TOYO CH-702 2/4-CHANNEL CARTRIDGE TAPE PLAYER SYSTEM
(Hirsch-Houck Lab Report)

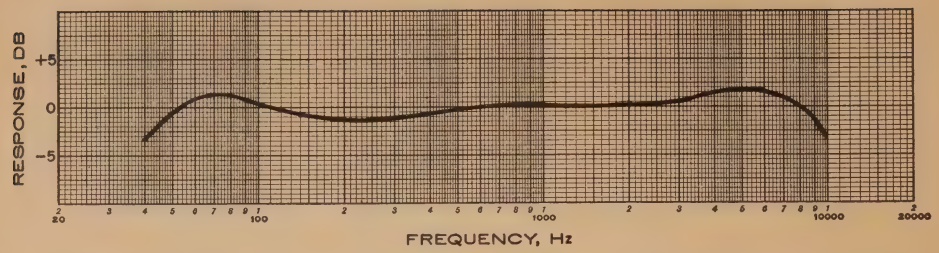


Because of the limited availability and high cost of 4-channel stereo amplifiers, most home 4-channel installations have followed the precedent established for the conversion from mono to stereo. With the addition of external devices, such as decoders and another stereo amplifier and another pair of speaker systems, the existing 2-channel setup can be converted to 4-channel operation. It may not be the most attractive or easy-to-use installation, but the results in terms of sound generally justify the expense and inconvenience.

Another solution to getting into 4-channel sound is offered by the *Toyo Radio Co. of America, Inc.*, in their Model CH-702 2/4-channel 8-track cartridge tape player system. There is no need to convert or add to your present 2-channel system since the CH-702 is a complete system that requires the addition of only four speaker systems to reproduce 4-channel stereo sound from RCA's "Q-8" cartridges. The CH-702 is a compact, lightweight unit, measuring just 18¾″ x 9¾″ x 5¾″.

Merely plugging a tape cartridge into the front panel loading slot powers the system. A pushbutton selects either 2- or 4-channel operation. In the 2-channel mode, the same signal appears in the front and rear outputs of each side. Lights indicate which track is being played.

Another pushbutton control can be used to advance the track sequentially. Normal 2-channel stereo cartridges have four groups of 2-channel program material, while the



Frequency response of Toyo CH-702 cartridge player is 5-10,000 Hz ±2.5 dB.

Q-8 cartridges contain two groups of 4-channel program material. Both types of cartridges automatically advance to the next group after completing one circuit of the endless tape loop.

Description. Although we have seen other 2/4-channel tape players, the Toyo CH-702 is unique in that it has built-in amplifiers. There are four 5-watt channels, with ganged volume controls and bass and treble tone controls, plus switchable loudness compensation. In addition to the usual left-right balance control, there is a front-rear balance control. The signal level in each channel is monitored at all times by four illuminated VU meters.

The rear apron of the CH-702 contains four phono jacks for the speaker connections (8-ohm speakers are recommended) and two slide switches which can be used to reverse each of the rear speakers relative to the corresponding front speaker.

The CH-702 has no provisions for inputs other than its own cartridge player or for driving external power amplifiers at line level. These omissions are, in our view, unfortunate since they restrict the versatility of the system. However, the CH-702 is inexpensive enough so that one need not be unduly concerned about obsolescence when advancing to a more elaborate system. Even in a small room (or, perhaps, especially in a small room) the benefits of 4-channel stereo reproduction can be striking.

Test Results. Our testing of the Toyo CH-702 player system was limited to playback frequency response measurements, using an Audiotex No. 30-213 test cartridge. The system met its specifications exactly. The frequency response was within ±1.5 dB from 45 to 9000 Hz and was down 3 dB at 40 and 10,000 Hz. The noise level was down 36 dB. The output waveform clipped at outputs corresponding to between 4.5 and 6 watts per channel into 8-ohm loads with all four channels driven simultaneously.

Most pertinent, no doubt, is the way the CH-702 sounded. In our opinion, it sounded very good, especially in view of its modest output power. Indoors, with rather inefficient speaker systems, it produced a listenable volume level in small- to medium-sized rooms. The discrete channel separation, made possible by the tape source, was impressive when the RCA Q-8 cartridge tapes were used.

We operated the system outdoors, using efficient outdoor speakers. It literally added another dimension to *al fresco* listening. In this case, its power was more than adequate.

Even 2-channel tapes were enhanced by playback through the CH-702 due to the fact that the rear speaker volume levels could be set a few dB below those of the front speakers, and there was some degree of ambience enhancement.

The Toyo Model CH-702 2/4-channel cartridge tape player, less speakers, sells for $169.95. With four low-cost speaker systems, it is possible to obtain a 4-channel stereo system for about $300, which certainly makes the CH-702 a good value.

Circle No. 76 on Reader Service Card

PIONEER PL-12A RECORD PLAYER (Hirsch-Houck Lab Report)

The *Pioneer Electronic Corp.* Model PL-12A is a complete stereo record player consisting of a turntable, tone arm, and cartridge, all of which are mounted on a walnut base with a hinged, removable dust cover. The assembly procedure, consisting of removal of a few transit screws from the turntable, installation of the turntable platter, and fitting the counter weight and car-

tridge shell to the tonearm, takes only a few minutes to perform and is simplified by reading and following a very clearly written and illustrated instruction manual.

Product Description. The 12-in. cast aluminum platter, weighing 2 pounds, is belt driven by a synchronous motor. A lever on the motor board shifts the belt on a stepped drive pulley for 33⅓ and 45 rpm. The PL-12A can be used in almost any part of the world since it is supplied with interchangeable 50- and 60-Hz drive pulleys and a switch under the turntable for selection of either 110-130- or 220-240-volt ac operation.

The tubular tonearm has an adjustable counterweight to permit balancing the cartridge mass and setting the tracking force. Antiskating compensation is supplied by a small weight suspended on a thread that passes over a notched horizontal bar mounted on the tonearm just behind the pivots. The instruction manual indicates which of the five notches to use for any tracking force between 1.5 and 4 grams.

The cartridge shell, which mounts to the tonearm with a knurled locking ring (similar to the system used on a number of European tonearms), has an attached metal finger lift. The cueing control, called the "function lever," raises and lowers the tonearm gently with hydraulic damping in both directions. The turntable motor starts when the tonearm is lifted from its rest and shuts off when the arm is manually returned to the arm rest.

The unit, unlike most manual record players, comes with a cartridge, Pioneer's Model PC-35, mounted in its plug-in shell. The induced magnet cartridge contains a 0.5-mil spherical diamond stylus that is designed to track at forces between 2 and 3 grams. The shell has the standard ½" cartridge mounting screw centers, with slotted holes for overhang adjustment. The manual clearly shows how to install cartridges other than the PC-35 and how to make adjustments for correct overhang and minimum tracking error.

The player is supplied with attached 56" cables that are clearly and correctly identified with the proper channel designations. It also includes all necessary maintenance and adjustment tools: slotted and Phillips screwdrivers, tracking force gauge, lubricating oil and applicator, and 45-rpm center hole adapter that stores on a post on the motor board.

Laboratory Measurements. In our lab tests, the turntable exhibited low rumble, measured at −33 dB unweighted and −55 dB with CBS RRLL weighting. Wow and flutter were each 0.05 percent at 33⅓ rpm and, respectively, 0.07 and 0.05 percent at 45 rpm. These figures are well below the specified limit of 0.12 percent for the combined wow and flutter.

The turntable started and ran without change of speed at any line voltage between 70 and 140 volts, but it ran slightly fast—about 1.0 percent at 33⅓ rpm and 0.5 percent at 45 rpm—from the outset. It attained final speed in less than one revolution.

The tonearm had a good "feel," and its tracking error was less than 0.5° per inch for record radii between 2½" and 6". The tracking error was essentially zero near the inner grooves of a record (between 3" and 4" radius), which is the desirable condition for minimum distortion. The cueing worked smoothly and quietly. However, the arm had a noticeable outward drift during its descent, a consequence of the antiskating force (which was optimized according to instructions).

The cartridge tracked well at the 2-gram minimum recommended force. There was some symmetrical waveform clipping when playing 30 cm/s 1000-Hz test bands; this is an extremely high velocity. The very high level 32-Hz tones on the Cook Series 60 test record were tracked without groove skipping at 2 grams, although there was some distortion. The IM distortion was ac-

ceptable at moderate velocities. However, even the highest recorded velocity of 27.1 cm/s did not cause the stylus to mis-track severely or lose contact with the groove. The output of the cartridge was 5.3 mV at 3.54 cm/s.

The frequency response, measured with the CBS STR100 test record, showed a large high-frequency resonance in the vicinity of 1500 Hz. The high-frequency response was not noticeably affected by added shunt capacitance. Channel separation was 15-20 dB up to 6000 Hz, reducing to 2-8 dB above 1200 Hz.

We evaluated the tracking ability of the PC-35 cartridge subjectively with the Shure TT-101 "Audio Obstacle Course" record. Except for the higher levels of orchestral bells and harpsichord, the cartridge acquitted itself well. In general listening quality, the PC-35 sounded good, exhibiting just a trace of extra brightness when compared with "best-quality" cartridges with essentially flat responses to 20,000 Hz.

Since the PC-35's increased output is in a frequency range where most speakers are somewhat deficient, it could very possibly exhibit a more satisfying sound than a flatter cartridge, just as long as its tracking abilities are not exceeded.

Summarizing, the Pioneer PL-12A is a fine value in a complete record playing system. Except for its small speed error—which would probably go undetectable by all but the most discriminating listener—the turntable is of excellent quality. The tonearm appears to be well made, and we infer from the range of antiskating force adjustment available that it can be used with cartridges tracking at 1.5 grams. In the unlikely event that the cartridge sounds too "brilliant," it can be easily replaced with almost any other cartridge of the user's choosing presently available.

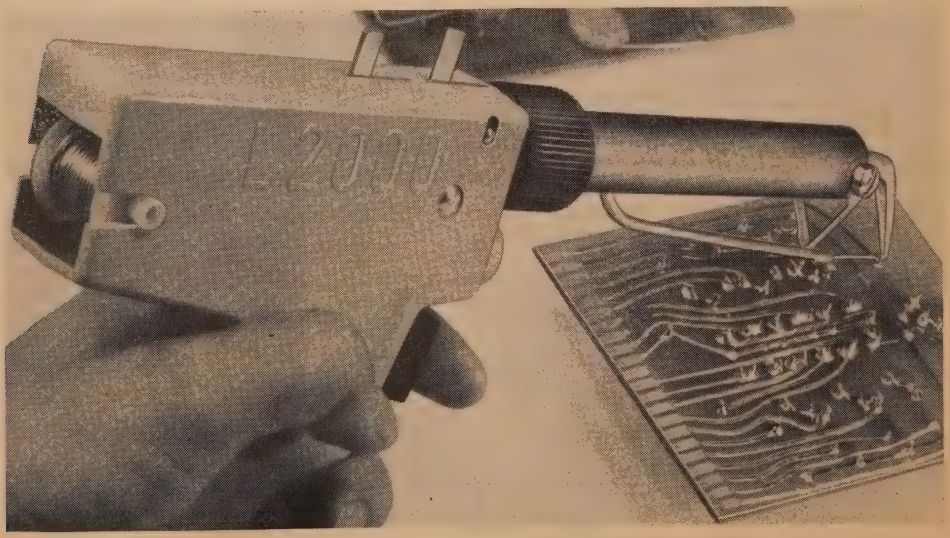
We doubt that most people will want to substitute cartridges. But even without the PC-35 cartridge normally supplied, the tonearm and turntable are well worth the asking price of the PL-12A. With the cartridge, the PL-12A is certainly a lot of record player for only $89.95.

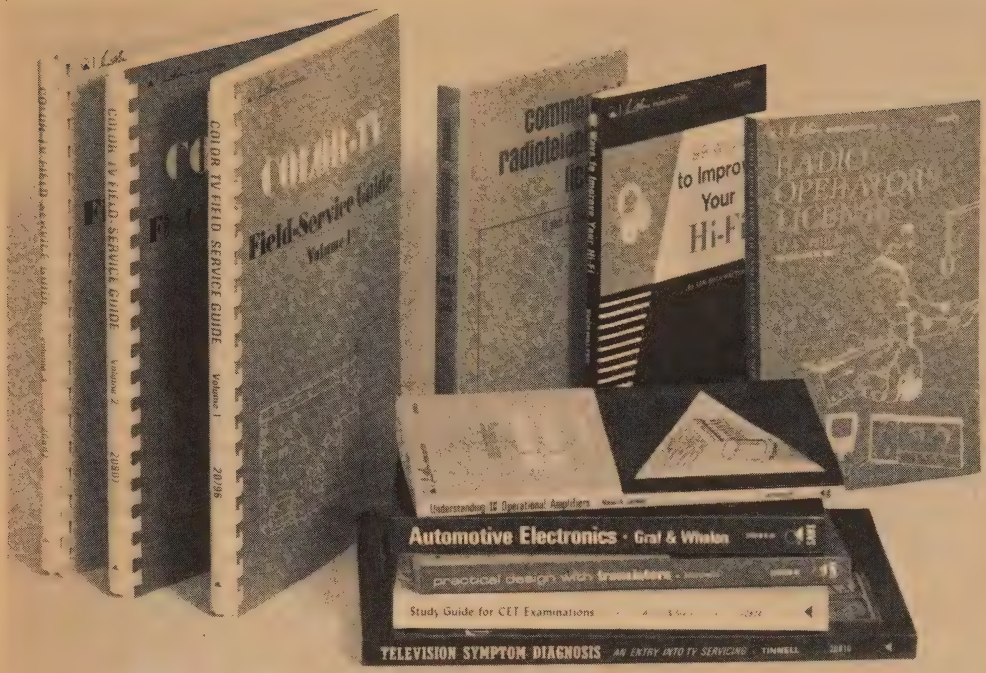
Address: Pioneer Electronics Corp., 178 Commerce Rd., Carlstadt, NJ 07072

BILECTRO "ONE HANDER" SOLDERING TOOL

One thing that we have been pleased to see in recent years has been the upsurge in what we appropriately call "third hand" tools. A couple of examples have already been discussed in this column in recent months; now we have a third to talk about. The "One Hander" soldering tool made by *Bilectro* is something that all of us two-handed people have been praying for for years.

The One Hander is a clean-looking soldering tool, designed along the lines of a gun or pistol but with a futuristic form. While the One Hander is shaped like a pis-





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tol, it does not operate in a manner we have come to associate with soldering pistols. Actually, the tool is a high-quality soldering iron mounted on a pistol frame. Plugging the line cord into an ac outlet immediately powers the heating element. The trigger on the pistol grip has nothing to do with powering the element; it is there for an entirely different purpose.

Designed to appeal to a wide range of users, the One Hander is available in seven different electrical configurations to provide from 20 to 100 watts of heating power. A selection of five different soldering tips is available to suit virtually any type of soldering operation. The soldering tips are scale resistant. They are coated with a non-oxidizing metal that never needs tinning (however, we recommend tinning as an aid to "wetting"), requires only occasional wiping, and should never be filed or sanded.

The pistol shape of the soldering tool is a practical design that permits more comfortable operation by the user as opposed to the sometimes uncomfortable position in which most pencils and irons have to be held. This is especially true with the cumbersome high-power industrial irons now in use. The handle of the One Hander serves a dual purpose; in addition to providing a comfortable grip, it has facilities for storing up to 15 ft of cored wire solder.

A mechanical system operated by the trigger feeds the solder at a rate determined by trigger travel directly to the point where the heated soldering tip and work meet. The soldering tip is angled in such a manner that it assists in locating and seeing the work and facilitates proper joining with the fed solder. This arangement insures that the solder is melted by the heat at the work and not by the actual soldering tip. This makes for the best kind of soldering.

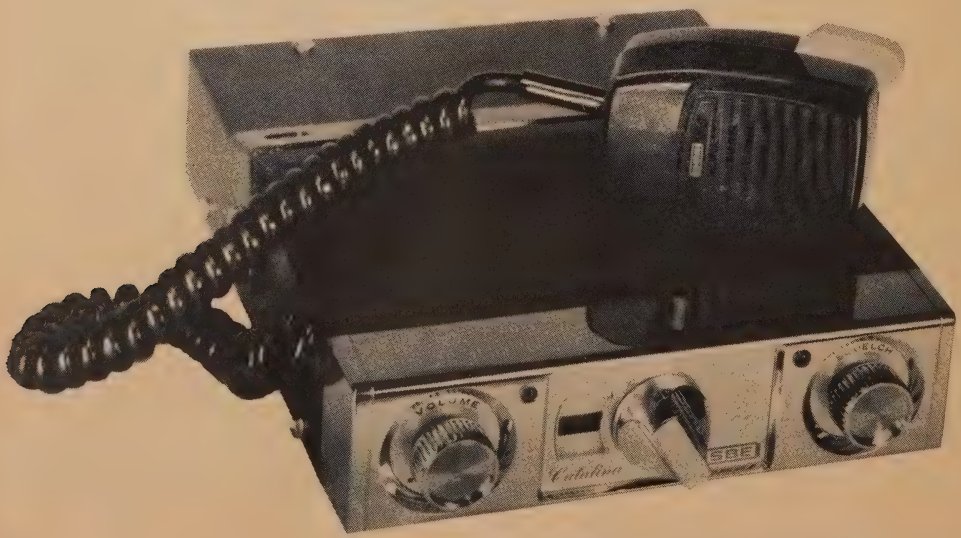
We tried the One Hander in repairing a defective transistorized circuit that came into the shop. Now, for the first time, we can get rid of the weird little mechanical gadgets that we used to hold things down and balance chassis elements while one hand supported the replacement part and the other hand kept the part in place. We found the One Hander to be very handy indeed and have concluded that it is a must for every shop. Price is $23.95.

Circle No. 77 on Reader Service Card

SBE "CATALINA" 23-CHANNEL CB TRANSCEIVER

It is often difficult to find anything really different about a piece of Citizens Band equipment. From an electronics viewpoint, the SBE "Catalina" made by *Linear Systems, Inc.*, is no exception. However, in some respects, this CB transceiver does have a few extras to offer.

First of all, it is a 23-channel frequency-synthesized unit that carries a price tag of only $99.95. This low price is really hard to beat for an all-channel solid-state transceiver that comes equipped with all the necessary crystals.



Designed primarily for mobile use, the Catalina has the usual rough 6½" wide by 7½" deep dimensions. But its height, only 1½", makes it small and compact and ideally suited for installation in large or small vehicles where space is at a premium.

It is one of the most attractive transceivers available, styled with a clean-cut panel and mirror-chrome finished knobs to provide an appearance well suited to custom installation in the most expensive cars. The Catalina, in keeping with simplicity of operation, has no unnecessary frills. Aside from the channel selector, there are only two other controls; one for volume and the other for squelch. The control knobs are edge knurled to provide for easy grip and are large enough to give a "solid" feel.

A difficulty often encountered with compact units with small panel height is that the selector dial dimensions are usually cut down, limiting the space for channel numbers and adding to the problem in reading. This situation has been overcome in the Catalina by the use of a flexible plastic dial, the unseen portion of which folds away behind the panel. The result is considerably larger channel numbers than would normally be expected of compact transceivers.

The overall compactness of the Catalina is enhanced by a smaller than usual push-to-talk dynamic microphone that fits neatly into the palm of the hand.

Among the other features often found in CB rigs are tiny jewel-like lamps that indicate when operating power is on and when the transmitter carrier is on. The dial is illuminated from the back. The lamp for the carrier-on function varies in intensity as modulation varies.

As generally found, the Catalina's loudspeaker is mounted facing downward at the bottom of the case. Also included is the customary speaker output jack to allow the user to plug in a more advantageously placed speaker. There is no provision for public-address in the Catalina.

Technical Notes. The receiver section takes advantage of double conversion. The first i-f is approximately 11 MHz which, with the high-Q circuitry at the r-f amplifier and the first mixer, provides a measured image rejection of 75 dB. The i-f signal rejection at the first i-f measured out at 60 dB.

The second i-f is fixed at 455 kHz with selectivity obtained by using a quadruple-

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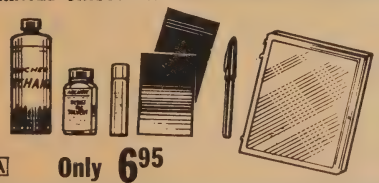

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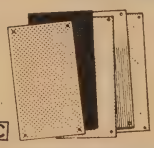

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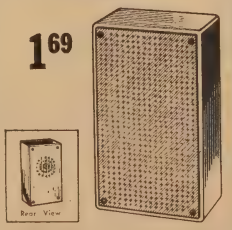

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tuned bandpass-coupling circuit at the i-f amplifier input. Adjacent channel rejection checked out at between 40 and 43 dB.

A full-time automatic noise limiter is a series-gate type which we would like to have found somewhat more effective. The squelch is adjustable over a sensitivity range found to be 1-500 μV. The audio output power of the receiver is rated at 2 watts with 10 percent distortion.

Frequency control uses a synthesizing system where six crystals nominally at 38 MHz or so are used for local oscillator injection at the first mixer and four crystals near 10.5 MHz are employed for the same purpose at the second mixer. Various combinations of one each of the 38- and 10.5-MHz crystals provide the required i-f at each mixer output in relation to the incoming signal's frequency.

On transmit, a group of nominal 11-MHz crystals in conjunction with the 3-MHz crystal-controlled frequencies provide on-channel excitation for the transmitter. The frequency tolerance is rated at 0.003 percent. This is what we measured on all channels except for four that deviated by approximately 0.004 percent. In all cases, the transmitter frequencies fell within the legal limit of 0.005 percent tolerance.

Multi-section output circuitry, designed for matching to 50-ohm loads, is used at the r-f power output amplifier where we found husky inductors wound with larger than usual wire. Operation is at the legal 5-watt input limit. The carrier output power, while using a 13.6-volt dc source, measured 3.5 watts (rated at 3 watts $\pm$0.5 watt).

A speech clipper in the transmitter's a-f section maintains a high average modulation level. A low-pass filter is used to attenuate a-f harmonics normally created by clipping, thus minimizing an undesirably broad signal. Although the clipper does limit the positive-peak modulation to 100 percent while the filter tends to smooth out the waveform, the negative-peak modulation goes beyond 100 percent and thus can cause breakup in the carrier. The latter is a common characteristic of many CB rigs. Ordinarily, this could be a potential cause of splatter; however, while operating the Catalina at voice frequencies, a spectrum analysis indicated that the signal did not spread out beyond the normal channel separation limits.

Other Performance Data. The Catalina handles nicely and the large size channel numbers make identification somewhat easier than usual. Had the numerals been made white instead of green, however, they would have been even easier to read. Channel 9 presents no legibility problem since it shows up as a bright red.

Plenty of sensitivity is available, measured at 0.5 μV for 10 dB S+N/N. The agc response is unusually flat, providing a relatively uniform a-f output under a wide range of signal-input levels. This was evidenced by only a 2-dB a-f output change with an r-f input signal level change of 80 dB (10-100,000 μV). As is the case with many solid-state CB transceivers, receiver crossover birdies—spurious responses—may be experienced with signals of 1000 μV or more.

Operating at 13.6 V dc, the current drain for the receiver, when squelched, is 250 mA; unsquelched and at full audio output, it was 1.1 A. At full modulation, the transmitter draws 1.5 A.

The SBE Catalina is supplied with a push-to-talk microphone, mike hanger, connecting cables with in-line fuse (system operates with either negative- or positive-ground system), and mobile mounting bracket. The unit may also be used for base station work in conjunction with an accessory ac power supply.

Circle No. 78 on Reader Service Card

EICO SOLID-STATE FET VOM (Model 239)

A bench VTVM is a must if you do any kind of shop electronic work. But for field work where an accurate instrument is needed, the conventional VTVM, dependent on an ac power source, is useless. What is needed in field work is a battery-powered instrument with all the accuracy and minimum circuit loading of a good VTVM. Fortunately, solid-state electronics has made such an instrument possible in the form of a transistor voltmeter, or TVM.

Eico Electronic Instrument Co., Inc., has recently made available one of these versatile TVM's as their Model 239, selling in kit form for $39.95 and in wired form for $59.95. The 239 has some good specifications: seven ranges for dc voltages capable

of measuring to 1000 volts full-scale with 11 megohms input resistance; seven ranges for ac voltages to 1000 volts at 1 megohm and useful to 25 MHz; and seven resistance ranges capable of measuring from 0.2 ohm through 100 megohms. All readings are displayed on a clearly marked 4½″ scale of the 200-μA meter movement.

The power for the 239 comes from three conventional 9-volt batteries with a separate 1.5-volt D cell supplying the power for resistance measurements. The physical size of the instrument is 8½″ X 5″ X 5″ and weight is 3 pounds.

The measuring probe supplied with the 239 is the well-known Eico "Uniprobe." If the user desires to extend the response way out, he can attach the optional PRF-11 probe (also available from Eico) and obtain usable response to 250 MHz. On the other hand, if very high voltage measurements are required, the optional Eico HVP-2 probe can be attached to allow the 239 to accommodate up to 30 kV.

After using the Model 239 on the test bench, we like the idea of having a line-independent instrument that provides all the facilities and versatility of a VTVM. And, after making some tests, we have determined that measurement accuracy was well within the manufacturer's specifications. In field service, the instrument absorbed some pretty rough service-truck trips and survived unscathed.

From a design point of view, the circuit is a no-nonsense arrangement (shown

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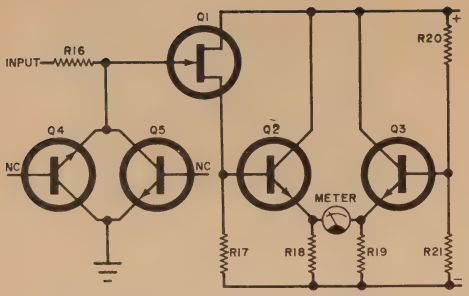


FET Q1 acts as voltage-variable resistor controlling base current of Q2. Q4 and Q5 are wired as protective diodes.

above in simplified form). The input comes into the gate of high-impedance FET *Q1* which drives a differential pair consisting of the *Q2/Q3* circuit. Regardless of the parameter being measured, the meter indication is a function of the dc level applied to the gate of *Q1*. This is what gives the instrument a very high input impedance. Note that the base current of *Q3* is held constant by the voltage divider made up of *R20* and *R21* which maintains a fixed voltage across *R19*.

Operation of *Q2* is controlled by a voltage divider consisting of *Q1* and *R17*. When a dc voltage is applied to the gate of *Q1*, the FET's source voltage is coupled directly to *Q2*, and because *Q1* acts as a voltage-variable resistor, the base of *Q2*—and hence its emitter voltage—follows the gate input voltage. This unbalances the emitter-to-emitter voltage and the meter pointer's swing follows accordingly.

Transistors *Q4* and *Q5*, in conjunction with *R16*, protect *Q1*'s gate circuit from accidental overloads. With the bases unconnected, these transistors act as high-quality temperature-compensated zener diodes. The parallel transistor combination presents an almost infinite impedance to voltages up to 10 volts. However, it becomes essentially a short circuit at high voltage, with the excess voltage dropped across *R16*.

With all of the features and versatility it has going for it, we feel that the relatively small investment—especially for the kit version—is well worth it for the Model 239 FET VOM. Predictably, it will find a lot of service life and use on both the work bench and in the field.

Circle No. 79 on Reader Service Card

SENCORE COLOR GENERATOR (Model CG159)

Like all other test instruments, color generators are constantly being improved. The latest unit we had a chance to test was the *Sencore, Inc.*, Model CG159 "Color King III" Deluxe Color Generator. Selling for $169.50, this new generator represents a good step forward for the color-TV service technician.

The Color King III has all of the usual features expected of a good color generator: switch-selectable horizontal and vertical lines, crosshatch, dots, and color bars; output level control; low-band TV channel selector switch; and switchable 4.5-MHz sound carrier. But there are other welcome features, too. For example, there are two extra patterns available: a single crosshatch and a single dot. The extra patterns can easily be positioned anywhere on the picture tube screen by operating a pair of controls on the front panel of the generator. We found these two patterns an excellent means of quickly checking convergence anywhere on the tube screen.

The second unique feature we like is a

DOT SIZE control located up front for easy access. This is one of those "I wish I had" controls many technicians would like in all color generators. With it, the user can quickly set the dot size he feels most comfortable working with. Other generators employ a fixed-size dot.

Three more controls which, when they

are available at all, are usually buried inside the case of the instrument are located out in front (again for easy access) in the Color King III. These are for horizontal hold, horizontal lines, and vertical stability.

Another plus for this new color generator is its built-in automatic temperature control which thermostatically maintains the interior at a constant 80° F. This feature provides operational stability over prolonged periods of time and is especially useful when the instrument is taken in from a cold service truck on those biting winter days to a warm shop or home. Just plug the Color King III into a convenient ac outlet and the automatic heater quickly brings the interior up to proper operating temperature. And, if you happen to live in a warm, humid climate, the heater will drive out any humidity.

Incidentally, the Sencore people take pride in their "Perma-Lock" circuits used in the color generator. A look at the schematic diagram shows that instead of the digital countdown systems used in many competing generators, the Color King III employs blocking oscillators that appear to be of vintage design. However, starting with a 188.8-kHz crystal oscillator that feeds the countdown stages, a sharp circuit man will note that not only is the positive dc line controlled by a zener diode to 12 volts but that this again passes through a zener controlled series-pass transistor to obtain 7.4 volts for the countdown stages. Furthermore, each of the countdown stages is coupled to another voltage reference (a transistor acting as a temperature-compensation diode), and when all this voltage regulation is combined with the thermostatically controlled heater, excellent stability results.

All the low-band vhf channels, 2 through 6, are available at the flick of a switch. Each is preset on frequency and there is no guesswork required to figure out just what channel you have tuned the rf to.

Mechanically, the American-built Color King III is very portable, measuring only 10¼" X 9½" X 4". The cover, which is detachable, has a 9" X 8" mirror that comes in very handy during behind-the-set convergence steps.

Circle No. 80 on Reader Service Card

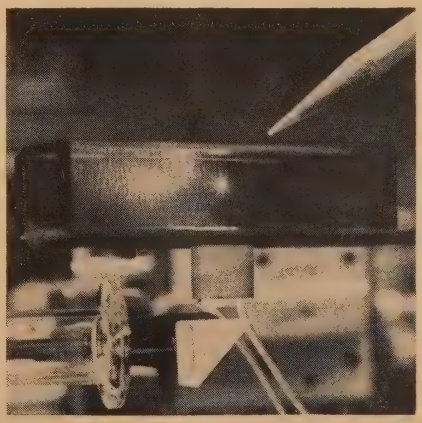
LASER LIGHT SUPPORTS TINY GLASS SPHERES

Using a beam of laser light, Bell Labs scientists have raised small transparent glass spheres off a glass surface and held them aloft for hours in a stable position. The experiments, which demonstrated optical levitation for the first time, were conducted by Arthur Ashkin and Joseph Dziedzic.

The new technique is expected to provide simple, precise methods for manipulating small particles without mechanical support. It could be useful in communications research to measure the scattering loss caused by particles, either in the atmosphere or in other transmission media.

The laser beam is focused upward on the glass sphere which is about 20 microns in diameter. Radiation pressure from the light not only counteracts gravity and raises the particle, but also traps the sphere in the beam and prevents it from slipping out of the beam sideways. The experiment has been demonstrated in air and in a partial pressure.

The sphere is launched by lifting it off a transparent glass plate with the light beam. However, initial molecular attraction between the sphere and the glass plate is broken acoustically by vibrating a ceramic cylinder attached to the plate. Once aloft, the sphere can be moved up and down or sideways very precisely by changing the position of the focus of the laser beam.



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by Brice Ward

If you are interested in a lucrative career in computer maintenance, this book can probably do as much for you as can a 1000-hour course in computers. Written for the working technician who has some background in semiconductor circuitry, the Handbook starts out with a brief introduction to computer systems and explains the basic similarities between all computers. It then goes on to coding systems, number systems, computer circuits and logic diagrams. Finally, binary Boolean algebra and system block diagrams are discussed in detail. Part two deals with a small representative computer. Topics include registers, memory, arithmetic, control, and input-output equipment. Part three covers specific examples of computer maintenance, including instruction sets and diagnostic routines.

Published by Tab Books, Blue Ridge Summit, PA 17214. Hard cover. 480 pages. $10.95.

QUESTIONS & ANSWERS ABOUT MEDICAL ELECTRONICS

by Edward W. Buckstein

The application of electronics to the field of medicine has created a long list of strange and impressive terms such as plethysmograph, ballistocardiograph, and electroencephelography. What do these terms mean and how can they affect our lives? How is electronics used in modern medical diagnosis and treatment? The answers to these and more questions are given in this new authoritative book. The text discusses the means for detecting, displaying, and recording the electrical signals produced by the body; heart signals, brain waves, and muscle potentials; and sound and ultrasound, pressure and displacement, resuscitation, therapeutic procedures, X-rays, and radioactivity.

Published by Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis, IN 46268. Soft cover. 96 pages. $2.95.

THE TRUTH ABOUT CB ANTENNAS

by William I. Orr and Stuart D. Cowan

Working on the assumption that very few CB stations operate effectively and give peak per-

formance—and that the trouble in most cases can be traced to the antenna—the authors set out to help the average CB'er improve the situation. With many illustrations and a style that is very enjoyable to read, they explain basic antenna theory, give construction data for several popular antennas (Monster Quad, Yagi, etc.), and tell how to install your antenna (whether homemade or purchased) in order to get the most out of the system.

Published by Radio Publications, Inc., Box 149, Wilton, CT 06897. Soft cover. 240 pages. $4.95.

HOW TO TROUBLESHOOT A TV RECEIVER Third Edition

by J. Richard Johnson

This practical guide to TV servicing continues, in the third edition, to emphasize preparation, planning, and method of approach as the key factors in successful troubleshooting. These principles are applied to the various trouble-spots in today's receivers such as controls, tubes and solid-state devices, picture distortion, and sound troubles.

Published by Hayden Book Co., Inc. 116 W. 14 St., New York, NY 10011. Soft cover. 160 pages. $4.50.

OPERATIONAL AMPLIFIERS DESIGN AND APPLICATIONS

edited by Tobey, Graeme, and Huelsman

Written primarily for the design engineer who uses operational amplifiers, this book will also be of great service to technicians and experimenters/hobbyists, who are finding more and more that the op amp is a valuable tool in many circuits. The first section deals with the design of the op amp—characteristics, inputs, outputs, etc. In the second section are a number of practical applications—in linear, nonlinear, and conversion circuits.

Published by McGraw-Hill Book Co., 330 W. 42 St., New York, NY 10036. Hard cover. 473 pages. $15.00.

HANDBOOK OF SIMPLIFIED SOLID-STATE CIRCUIT DESIGN

by John D. Lenk

The word "simplified" in the title is the key to this book's approach to circuit design. It starts with approximations or rules of thumb for the selection of components on a trial-value basis, assuming a specific design goal and a given set of conditions. Concentrating on simple, practical approaches to circuit design, not on circuit analysis, theory is at a minimum.

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Mac's Service Shop

By John T. Frye, W9EGV, KHD4167

RADIO INTERFERENCE: CAUSES & CURES

A COLD, raw, January wind numbed Mr. McGregor's fingers as he unlocked the door of his service shop and stepped inside. There he paused in the cosy warmth to unbutton his coat and survey proudly, as he often did, his place of business. Matilda, the office girl, had left the counter and her desk as neat and clean as always; and through the open door leading into the service department he could see the night light reflecting off the gleaming faces of the service instruments above the bench. The place had a good, solid, responsible look about it, he thought contentedly.

There was a sound of running feet outside, and Matilda and Barney, Mac's redheaded Irish assistant, came in together. "Someone must have sprayed circuit-cooler around out there," Barney complained. "Man, it's *cold!*"

"If you'd wear an overcoat as Mac and I do, you wouldn't go around with your teeth chattering," Matilda observed tartly as she removed her stylish floor-length coat to reveal a skirt as short as the coat was long.

"Ha! You don't wear that coat to keep you warm," Barney retorted. "You just enjoy the shock effect when you take it off."

"Here, here! I'd better separate you two," Mac interrupted. "Barney, you come on back to the service department with me. When you're as old as I, you'll know better than to get into an argument with a woman about clothes. A man hasn't won that argument since Eve picked out the fig leaves. Anyway, I want to brief you on your first service call."

"What's unusual about it?" Barney wanted to know, shrugging off his quilted jacket and perching himself on the bench.

"CB transmissions are being heard over the PA system in the Sorensen Funeral Home. This amplifier is used to furnish background music during funerals, and it's pretty disturbing to hear a CB operator working skip right in the middle of a service. I've an idea or so that may help clear up the complaint, but perhaps we'd better run over the general subject of interference to electronic equipment caused by the operation of nearby transmitters, be they CB, amateur, special services, or even broadcast."

"I'm being paid to listen, so go right ahead," Barney invited, stretching out on his back and closing his eyes.

Interference to Broadcast Sets. "That's what I like: a good alert audience," Mac said sarcastically. "Anyway, let's start with interference to broadcast reception. The 'tunable' type is so-called because it's only heard at certain places on the dial. True image response accounts for this kind of interference from amateur stations operating in the 1800-2000-kHz band and for higher frequency broadcast stations that can also be heard on the low-frequency end of the band.

"As you know, most present-day superhet receivers use a 455-kHz i-f. To receive a 1000-kHz station, the local oscillator of such a receiver is set to 1455 kHz to beat with the broadcast signal and produce a difference frequency of 455 kHz that will pass through the i-f amplifier. But suppose an amateur station is operating nearby on 1910 kHz. If this signal, which is naturally quite strong in the immediate area, reaches the input of the receiver mixer—and there is only the limited rejection capability of the tuned loop antenna to prevent this—the amateur signal will beat with the local oscillator and also produce a 455-kHz difference signal that will pass through the i-f amplifier, too, and make it seem to the listener the amateur is transmitting squarely on top of the broadcast station, even though the ama-

teur is operating properly in his own band. Actually, the receiver is listening where it shouldn't!

"As long as the local receiver oscillator operates on the high frequency side of the station being received—and this is usually the case—the true image frequency is always twice the i-f, or 910 kHz higher in frequency than the dial setting of the receiver. This means that images of strong local broadcast stations operating between 1450 and 1630 kHz are sometimes heard between 540 kHz and 720 kHz on the dial, in addition to their proper dial settings."

"You keep saying 'true image.' Are there other kinds?" Barney asked.

"Yes, the oscillator-harmonic images. The local oscillator has harmonics that can beat with amateur or other signals to produce false responses in the broadcast receiver. For instance, in the example we were talking about, the third harmonic of the local oscillator would be 4365 kHz. This could beat with an amateur station operating on 3910 kHz in the 75-meter band to produce the difference i-f frequency of 455 kHz and again make it seem the 75-meter station is operating on top of the 1000-kHz broadcast station. Fortunately, as the order of the harmonics increases, their strength ordinarily diminishes.

Cross-Modulation & Non-Tunable Interference. "Cross-modulation is another type of BCI identified by the fact that the interference is heard only when a broadcast carrier is tuned in. Between stations the interfering signal is not heard. Cross-modulation is the result of rectification of the strong local signal by one of the early stages in the receiver. The output of this stage carrving the r-f or i-f signal goes up and down with the modulation of the local signal, and so the broadcast carrier is actually modulated by the local signal as well as by the modulation imposed upon it in the studio. Both the broadcast modulation and the modulation of the interfering signal are heard simultaneously. Cross-modulation of CB reception on one channel by the modulation of a powerful signal several channels away is a very common occurence.

"Finally we have the non-tunable type of interference. This is the kind in which the interfering station is heard 'all over the dial.' This happens because the interference is affecting the untuned audio stages rather than the tuned r-f and i-f stages. In fact, this type

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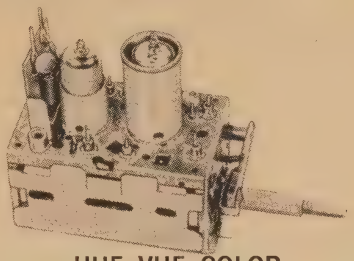

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of interference is often found where there are no tuned stages—just audio stages such as you find in a PA amplifier, electric organ, intercom, etc. Positive swings of the carrier appearing on the grid of the audio stage drive it into the conducting region. Electrons attracted to the grid cannot leak off rapidly enough through the high value of grid resistance, and their accumulation biases the tube to cut-off. This makes a grid-leak detector out of what is supposed to be an audio amplifier, and the detected modulation of the interfering signal is heard in the speakers. This usually takes place in an input stage with a very high value of grid resistance, but it can happen in following stages. Effect of volume control action on the interference will tell you if the trouble is arising ahead or behind the control. The same sort of thing happens with solid-state receivers, too."

Getting Rid of It. "Okay, you've told me how the interference happens, but I'm more interested in how I get rid of it."

"In all the cases I've mentioned, about all you can do is try to reduce the strength of the interfering signal reaching sensitive areas of the equipment being interfered with by means of shielding, filtering, and bypassing. You can't do much to keep the signal off the unshielded loop antenna of the average broadcast receiver, although changing the position of the receiver's loop antenna may help; but a lot of the signal pickup of such a receiver is through the light lines. The reduction in received signal strength when switching from line to battery operation in a two-way receiver demonstrates this. For that reason, just doubling up the line cord to cut down on its pickup may help. A properly installed line filter will probably be more effective, especially if it is installed inside the set.

"If such measures do not clear up the trouble, modification of the circuit may be necessary. This is especially true with non-tunable interference to a receiver or interference with an audio amplifier. Incidentally this type of interference usually comes from a transmitter operating above 20 MHz, where a line cord may easily be a resonant quarter- or half-wavelength long, and so poke a lot of unwanted signal into the equipment."

"What circuit modifications are you talking about?"

"In vacuum-tube equipment grid leads can be shortened and shielded. A high value of grid resistor in an audio stage can be reduced to 2-3 megohms, and the grid may be bypassed with a 250-pF capacitor. Alternately a 75,000-ohm resistor may be connected between the grid and all other grid connections. This resistor, together with the grid capacitance, forms a high-frequency r-f filter. Solid-state equipment can also be treated in the same general way."

"You said you had some ideas that may help me with this funeral home job, didn't you?"

"Yes. They tell me the interference only started a week ago after we had that freak thunderstorm. Lightning blew a fuse in the amplifier and apparently did no other damage, but the interference from the CB transmitter next door showed up right after that. I have a hunch that lightning may have blown one or both of the 0.01-μF capacitors from each side of the line to ground. If so, this permits the r-f to follow the line cord into the amplifier. Check these first. If they are OK, try bypassing the leads to the speakers with 0.001-μF capacitors to the chassis. Make sure top and bottom shields of the amplifier are in place and are making good connections. If such shields are not furnished with the amplifier or have been misplaced, we may have to make some. Only after you have done all these things should you start modifying the circuit. Hey, what's wrong? You don't seem very keen about this job. Don't you understand what I've been telling you?"

"I understand all right. Don't forget I was a ham before I became a service technician. It's just where is the amplifier? The fronts of those places give me the willies, and I don't like to think about what I might run into behind the scenes."

"So that's it! Well, relax. The people at the funeral home particularly wanted you to come today because they have no 'customers' in the house and the CB operator will be available for testing. Okay?"

"Okay" Barney said, a sheepish grin creasing his freckled face as he slid off the bench and started putting on his jacket. "But suppose we continue this conversation one of these days and talk about television interference, or TVI. Of course I probably know most of what you can tell me, but it won't hurt to talk about it a little."

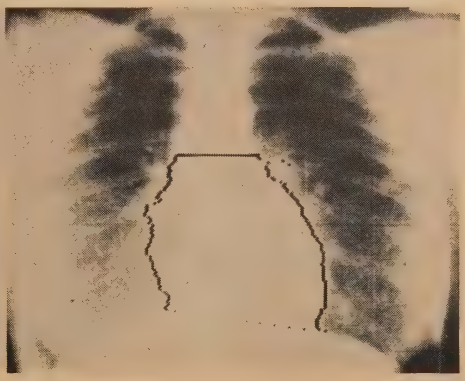
"Of course," Mac said, concealing a grin. "A little brushing up never hurts anybody. We'll do it at the first opportunity." ◈

Automated Radiological Diagnosis System

WHAT'S better than one doctor? Two doctors? No, an IBM-360 digital computer that has been properly programmed.

At the University of Missouri's Medical Center and College of Engineering they are using the 360 to perform certain diagnoses. In a recent test, pitting 10 experienced radiologists against the computer, both the digital system and the panel correctly diagnosed heart abnormalities 94% of the time. The computer correctly diagnosed normal hearts as normal 89% of the time, and the panel 83%. On diagnosing 135 cases, the computer was correct 73% while the panel hit 62%. What is more, the computer scanner had only a frontal view of each case, whereas the panelists had both front and side views. Each physician examined some or all of the 135 cases, with a total of 639 radiologist diagnoses available for comparison with the automated system. Work is presently underway in diagnosis techniques beyond heart ailments, which was the first phase. Respiratory, digestive and bone tumor routines are under development.

The automated system examines the X-ray images, and compares them with known standards to determine the presence or absence of abnormalities, and prepares a list of causes in order of probability. After feeding the results of the electronic scanning of the X-ray into the 360, researchers programmed the computer to define an area for enhancement (below left) and precisely trace the heart outline (below right). Analyzing the slope and length of the lines mathematically give the computer hints as to the presence or absence of rheumatic heart disease. In photo at right, Dr. Gwilym Lodwick, professor and head of the University radiology department is shown mounting an X-ray film for scanning. ◈



STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION (Act of August 12, 1970: Section 3685. Title 39, United States Code).

1. Title of publication: Popular Electronics.

2. Date of filing: October 1, 1971.

3. Frequency of issue: Monthly.

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8. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities: NONE.

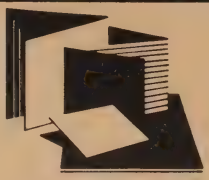
9. For optional completion by publishers mailing at the regular rates (Section 132.121, Postal Service Manual). 39 U. S. C. 3626 provides in pertinent part: "No person who would have been entitled to mail matter under former section 4359 of this title shall mail such matter at the rates provided under this subsection unless he files annually with the Postal Service a written request for permission to mail matter at such rates."

In accordance with the provisions of this statute, I hereby request permission to mail the publication named in Item 1 at the reduced postage rates presently authorized by 39 U. S. C. 3626.
William L. Philipps, Assistant Treasurer

11. Extent and nature of circulation:

	Average No. Copies Each Issue During Preceding 12 Months	Actual Number of Copies of Single Issue Published Nearest to Filing Date
A. Total No. Copies printed (Net Press Run)	466,496	428,819
B. Paid Circulation		
1. Sales through dealers and carriers, street vendors and counter sales	61,325	60,000
2. Mail subscriptions	309,608	278,400
C. Total paid circulation	370,933	338,400
D. Free distribution by mail, carrier or other means		
1. Samples, complimentary, and other free copies	7,500	7,500
2. Copies distributed to news agents, but not sold	87,293	81,800
E. Total distribution (Sum of C and D)	465,726	427,700
F. Office use, left-over, unaccounted, spoiled after printing	770	1,119
G. Total (Sum of E & F—should equal net press run shown in A)	466,496	428,819

I certify that the statements made by me above are correct and complete. William L. Phillips, Asst. Treas.



New Literature

The new 1972 catalog from *Edmund Scientific Co.*, lists over 4000 items including unique scientific tools; components such as lenses, prisms, wedges, mirrors, and mounts; and accessories of all types. Of special interest is an electronic calculator which adds, subtracts, multiplies, divides, and does machine calculations in milliseconds with an 8-digit entry and readout. In addition, there are a light emitting diode experiment kit, an infrared sensor alarm kit, an air pollution indicator, and a water test kit. Address: Edmund Scientific Co., 380 Edscorp Bldg., Barrington, NJ 08007.

A four-page brochure from *Hallicrafters Co.* describes the new Model SR-400A, "Cyclone III," SSB/CW 5-band transceiver with power to 550 watts PEP, exclusive power tube balancing circuit, 100/25 crystal calibrator, and many other built-in features. Data is also given on the patented Receiver Incremental Tuning which permits adjustment of receiver frequency independent of the transmit frequency, an optional fixed station blower kit, and VOX controls. Address: The Hallicrafters Co., Dept. PR, 600 Hicks Rd., Rolling Meadows, IL 60008.

An eight-page catalog from *Alcoknob Div.*, Alco Electronic Products, Inc., describes their line of hand-crafted, machined aluminum, control knobs, plus an expanded line of plastic knobs, all with spun aluminum inlay tops. Knobs include straight knurls, fluted knurls, diamond knurls, standards, skirted, concentrics, and specially made knobs to establish identity. Address: Alcoknob Div., Alco Electronic Products, Inc., P.O. Box 1348, Lawrence, MA 01842.

The new *Motorola* HEP HMA-07 Semiconductor Cross-Reference Guide and Catalog includes a complete product catalog giving ratings and characteristics for every HEP device—this in addition to the cross-references to other device numbers. Also included are 168 new hobby, dealer, and industrial M.R.O. devices just introduced. Address: Motorola Semiconductor Products, Inc., 5005 E. McDowell Rd., Phoenix, AZ 85005.

A new eight-page brochure from *Kester Solder,*

Division of Litton Systems, Inc., presents the company's full line of soldering products, including their "44" resin core solder, acid-core solder, solid wire, bar solder, TV-radio solder, and Kester Metal Mender "for a thousand uses." There are also soldering fluxes, soldering paste, and salts and a stand that serves as a "third hand" for the workbench. Address: Kester Solder, 4201 W. Wrightwood Ave., Chicago, IL 60639.

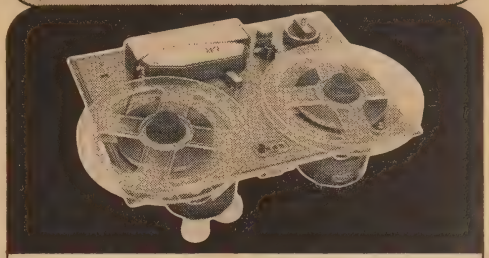
A brochure from *Midland Communications Co.* describes their new line of SSB/AM CB transceivers, available in base, mobile, or hand-held models. Other products include a new scanning monitor with automatic hi-lo intermix, a HELP mobile CB with automatic 2-channel logic scanner, and accessories such as power supplies, microphones, ac adapters, and crystals. Address: Midland Communications Co., P.O. Box 19032, Kansas City, MO 64141.

Heathkit is celebrating their 25th year in the kit business, and their new 1972 catalog (No. 810/72) reflects how far the company has come. Featured in the catalog are color-TV receiver kits, stereo/hi-fi equipment, stereo equipment credenzas and console cabinets, home appliances, automotive test gear and accessories, communications equipment and an extensive line of test and service equipment. Other features include guitar/instrument amplifiers, electronic organs, and a trail bike. Address: Heath Co., Benton Harbor, MI 49022.

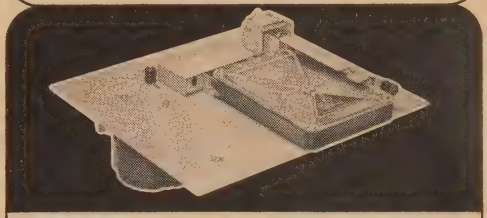
Many of the hi-fi and almost all of the digital electronic projects that have appeared in the pages of this magazine are listed as kits in the new catalog available from *Southwest Technical Products Corp.* Among the digital kit offerings are the Digital Logic Microlab, the popular series on the universal mainframe with various plug-in modules, and an IC experimenter series. The hi-fi series includes a FET Preamp and the "Tiger" power amplifiers. Other items featured are a theremin, psychedelic lighting systems, and SCA multiplex adapter, a power supply, and security alarms. Address: Southwest Technical Products Corp., P.O. Box 32040, San Antonio, TX 78216.

The 1971 Product Selection Guide describes all current product lines made by *Hickock Electrical Instruments Co.* These include digital multimeters, oscilloscopes and digital measuring systems, tube and transistor testers, data collection terminals, and card and industrial readers. The short-form catalog, No. 571, contains photographs of the instruments listed, short descriptions, abbreviated specifications, and prices. Address: Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, OH 44108.

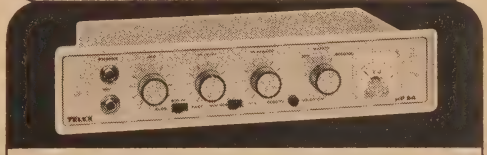
CUSTOM TAPE COMPONENTS



Model 87. Compact, inexpensive, yet highly reliable two speed, two motor open reel tape transport ideally suited for most manual recording/playback applications. Interlocked tape motion and record controls, pause and cue controls. Monaural or stereo head configurations. Available also three motor, electrically controlled series 230 tape transports.



Broadcast quality transports for all NAB type endless loop tape cartridges. Three models — manual, semi-automatic or automatic for broadcast, industrial or commercial applications. Single or dual speed, in monaural or stereo head configurations.



Matching electronics for above. RP 84, professional solid state, monaural record and playback preamplifier for tape transports with two or three heads. Selectable equalization from 1-7/8 to 15 ips. A-B monitor switch. Mixing of line and mike inputs. Bias synch provision for multi-channel applications. Phone jack, VU meter, record light. 30-18,000 Hz ± 3dB at 7.5 ips. Also model PB-10 playback preamplifier and model PA94F, 8 watt playback amplifier.

For free catalog and price information write

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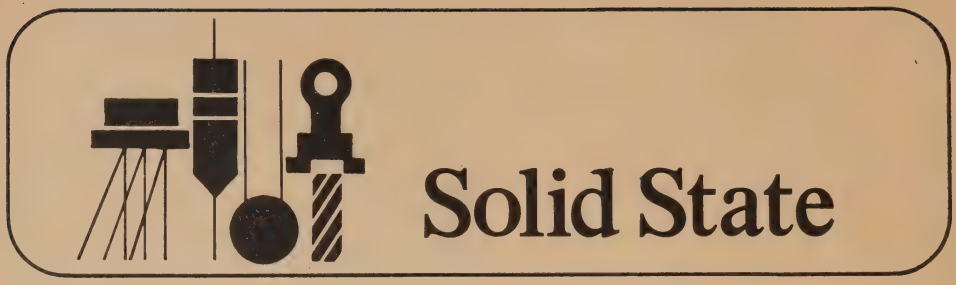


Solid State

By Lou Garner

TALLYING UP AND PREDICTIONS

A NEW YEAR, and time, once again, to face up to our annual predictions and to climb out on the proverbial limb in our forecasts of solid-state developments during the next twelve months.

First, however, a review and critique of our 1971 predictions. In our January column last year, we predicted:

• *The production of relatively inexpensive solid-state computers suitable for student use in public schools.* Home run! Low-cost computers designed for the educational market are now being offered by a number of manufacturers, including Logiconcepts, Inc. (22513 South Normandie Ave., Torrance, CA 90501), the Digital Equipment Corporation (146 Main St., Maynard MA 01754), and Scientific Measurements, Inc. (2945 Central, Wilmette, IL 60091). In addition, a British firm, Feedback, Ltd. (U.S. Subsidiary, Feedback, Inc., 431 Springfield Ave., Berkeley Heights, NJ 07922), has introduced a unique educational computer, the Abacus Model EC362/372, which is designed to enable students to follow data flow and instruction manipulation visually through all operations.

• *The introduction of a solid-state oscilloscope in the $100 to $150 price range, perhaps as a kit.* Home Run! And kudos to the Heath Company (Benton Harbor, MI 49022). Their Model IO-102 5" solid-state oscilloscope kit, priced at $119.95, fulfilled our prediction to a tee!

• *LED's priced at less than one dollar in unit quantities.* Home run! According to the firm's latest price list, Monsanto's type MV50 is now priced at only 85 cents in quantities of 1 to 9. Interestingly, a representative from a major semiconductor manufacturer chided your columnist for this prediction in early 1971, saying it had "no chance" of fulfillment. As it turned out, his firm was the one that broke the price barrier!

• *Medium- to high-power (10 to 50 watts, or more) IC audio amplifier devices in the "under $10" price range.* Home run! This was another wild one, for, at the time we made the prediction, high-power hybrid IC amplifiers sold for $50 or more, even in fairly large quantities. Today, however, you can obtain Solitron's BHA-0002 15-watt audio amplifier for less than $10 each in production quantities, and $10.20 each in quantities of 100. Sanken Electric Co.'s Model SI-1010Y 10-watt hybrid amplifier, distributed by Airpax Electronics (P. O. Box 8488, Fort Lauderdale, FL 33310), is available for $5.30 each in single quantities, and $3.45 each in production quantities (500 up.).

At the upper end of the audio power spectrum, hybrid IC amplifier prices have also taken a nose dive, with RCA's mighty *100-watt* HC1000 now available for only $20 each in large production quantities and Sanken Electric's husky 50-watt SI-1050A offered at less than $16 each in quantities of 500 and for $23.40 each, singly.

• *An expanded use of linear IC subsystems by both engineers and hobbyists, as well as the introduction of new subsystem devices comparable to gyrators and PLL's.* Home run! RCA's line of IC project kits has proven so popular that many dealers have had trouble keeping them in stock. For a look at what more advanced hobbyists have been doing, just review last year's copies of POPULAR ELECTRONICS. Among the many projects involving IC subsystems were a stereo decoder (October), a triggered sweep for scopes (July), a laboratory power supply (June), an audio filter/oscillator (May), and a melody synthesizer (February).

Space limitations prohibit our reviewing all of the new linear IC subsystems introduced during 1971, but among those discussed in this column were Signetics' SE/NE 540L class AB power amplifier and Motorola's MC1345 TV signal processor and MC1398P color processor (November), RCA's CA3088 AM receiver subsystem, CA3090 stereo multiplex decoder and CA3089 FM-IF subsystem (October), Signetics' SE/NE 566 function generator (July), Signetics' SE/NE 567 tone decoder and Lambda's LA5200 hybrid voltage regulators (June), Amperex's TAA560 (May), Motorola's MC1594L/1494L four-quadrant multiplier (April), and TRW's CA800 and CA600 hybrid broadband r-f amplifiers (March).

• *A unique solid-state microwave device based on a technological breakthrough.* Home run!

Several such devices were announced during the year, including a new tetrode and a unique Impatt diode.

Developed by a team of research scientist's at GEC's Hirst Research Center, Wembly, England, the new tetrode was produced using MOS technology and ion implantation techniques. It can provide a 17-dB gain with a 4.7-dB noise figure at 500 MHz and up to 10-dB gain with an 8-dB noise figure at 900 MHz.

The new Impatt diode was reported by Y. Fakatsu of the Electrical Communications Laboratory, Tokyo, Japan. With a breakdown voltage of 12.6 volts, an input current of 400 mA, and an operating voltage of 16.4 volts, the device has been used as an oscillator at frequencies in excess of 80 GHz, delivering up to 90.0-mW output.

• *The development of a new semiconductor or manufacturing technique.* Home run! For details on one of the latest production methods refer to our discussion of Signetics' "D-MOST" process in our October column.

• *Despite inflation and increased labor costs, a continuing drop in the prices of both IC's and discrete solid-state devices.* Home run! For evidence, just check late 1971 catalog prices against those for similar devices in 1970.

• *An interesting new semiconductor sensor.* Home run! A number of new solid-state sensing devices were introduced during 1971, including an improved phototransistor with sufficient output to drive TTL circuit loads or even to trigger power SCR's. The Quantistor from Sensor Technology (7118 Gerald Ave., Van Nuys, CA 91406), can furnish 70 mA output at an irradiance of 5 mW/cm^2, equivalent to about 100 ft-candles—or 11 mA at a mere 20 ft-candle level. With a maximum power dissipation of 600 mW at 25°C, the unit is furnished in a hermetically sealed TO-5 case with integral lens.

Even more exciting news on the sensor front, at least as far as future prospects are concerned, has come from one of our nation's top research centers. Scientists at MIT's Lincoln Laboratories in Lexington, Massachusetts, have been studying the use of trimetallic laser diodes as air pollution detectors. In operation, the diodes serve as narow-band tuned laser light sources in conjunction with photosensitive detectors to identify the spectral IR absorption characteristics of specific molecular pollutants. This permits more accurate and faster pollution monitoring than can be achieved using conventional analysis techniques.

• *A significant increase in the use of solid-state electronic equipment in bio-medical research and medical applications.* Home run! Virtually all of the medical electronic research equipment introduced during 1971 used solid-state circuitry, with many IC's rather than discrete component designs.

BTL scientists have developed an experimental heart pacemaker that obtains its operating power indirectly from the heart itself; while researchers at the Cox Heart Institute designed a solid-state pacemaker so small that it could be inserted into a vein in the neck by minor surgery, then passed down into the heart and attached to its inner wall with a simple pin-like clip.

Scientists and engineers at Stanford University developed a unique reading aid for the blind which featured a planar array of microminiature silicon phototransistors; while a team of Japanese researchers designed a catheter-type semiconductor radiation detector for tracer studies. Workers at Boston's Northeastern University developed an experimental hybrid dc-to-dc solid-state converter for powering implantable devices. And, as reported in our November column, a research team at the Army Institute of Research has been using state-of-the-art IC's to detect and sense brain waves.

Final score for our 1971 predictions—*10 home runs in ten times at bat,* or, in baseball's rating terms, a 1.000 batting average for the 1971 season.

Things to Come. Our crystal ball is dimmed somewhat by tears of joy and not as clear as we would like. For better or worse, however, here are our predictions for 1972:

The announcement of a new experimenter/hobbyist product line by a major semiconductor manufacturer. . . The introduction of an electronic calculator, perhaps as a kit, in the under $150 price range. . . *A virtually complete switch-over to IC audio amplifiers in standard consumer products in place of discrete device designs.* . . The production of an interesting new semiconductor control device. . . *The introduction of a unique solid-state automotive burglar system which eliminates the need for an external key switch.* . . The development of compact personal medical monitors. . . *The publication of a new series of hobbyist project manuals by a large component manufacturer/distributor.* . . The announcement of an exciting new solid-state electronic musical instrument. . . *A new development in the manufacture of light-emitting devices which will lead to substantial price reductions* . . . The introduction of a new thermoelectric product.

Useful Circuits. Tom McTaggart (66 Hibury Drive, Houston,TX 77024) has an intercom in his home workshop; but, as in many cases, he found that he would sometimes miss out on messages when using noisy power tools or wearing earphones. His solution was a simple visual alarm to alert him to incoming calls. Tom's circuit is illustrated in Fig.1.

Referring to the schematic diagram, step-up transformer *T1* samples the audio signals sent over the intercom line. These are amplified by *Q1* and used to activate a small light-emitting diode (LED). The circuit includes current-limiting resistor *R1,* and a sensitivity control

R2, to compensate for background noises.

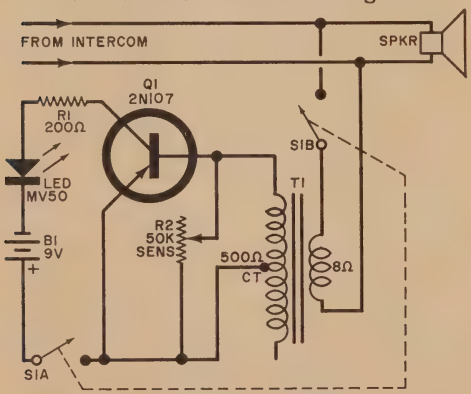
Standard components are used in the design: *Q1* is a general purpose pnp transistor such as a 2N107; the LED may be any inexpensive type, such as an MV50 or P2000, while *T1* is an inexpensive audio output transformer with a 500-ohm C.T. primary and 8-ohm secondary wired "in reverse" (i.e., 8-ohm winding to intercom lines).

In practice, the caller first whistles or speaks loudly to energize the LED and attract Tom's attention, then proceeds with his message.

Reviewing back issues of his favorite magazine, POPULAR ELECTRONICS, reader Daniel D. Mickle (5 Sunset Drive, Lodi, OH 44254), an assistant field engineer with the Northern Ohio Telephone Company, was intrigued by Fred Maynard's "Swimming Pool Splash Alarm," as described in the July, 1966 issue. Dan felt that the design, which required three transistors and an electromagnetic relay, could be simplified. He put on his "thinking cap" and devised a circuit requiring but a single transistor and relay. With further study, he simplified the circuit even more, substituting an SCR for the transistor and eliminating the relay. His final version is given in Fig. 2.

In operation, splash waves, as may be caused

Fig. 1. Simple addition to a wired intercom turns on LED when being used.



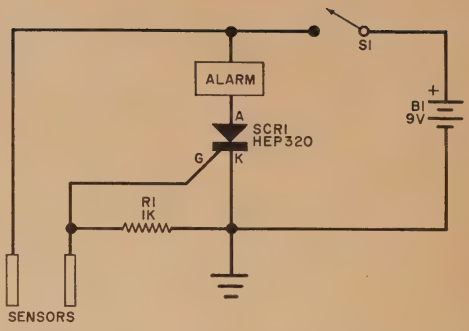


Fig. 2. When water shorts the sensor terminals, SCR1 turns on the alarm.

by someone falling or jumping into the pool, contact the sensor probes, which are mounted just above the swimming pool's water level. This closes the SCR's gate circuit, switching this device to a conducting state and actuating the alarm unit. The alarm continues until the system is reset by opening the main power switch.

Dan has specified inexpensive commercial parts for his circuit. The alarm unit may be a Mallory SC628 *Sonalert* or a standard dc buzzer or bell shunted by a small resistor to furnish a "keep alive" SCR anode current.

Except for the location and placement of the sensor probes, the circuit is not overly critical and may be assembled using any construction technique. The probes are small, closely spaced metal rods or wires mounted in such a way that they are not contacted by minor variations in pool water level or wind-generated ripples, but are simultaneously contacted by splash-created waves. Some experimentation may be necessary before the optimum installation is achieved.

Another interesting and potentially useful circuit is illustrated in Fig. 3. A low noise FET amplifier, this circuit was abstracted from Technical Memo TMF4, published by Crystalonics (147 Sherman St., Cambridge, MA 02140). Furnishing a voltage gain of 25 with

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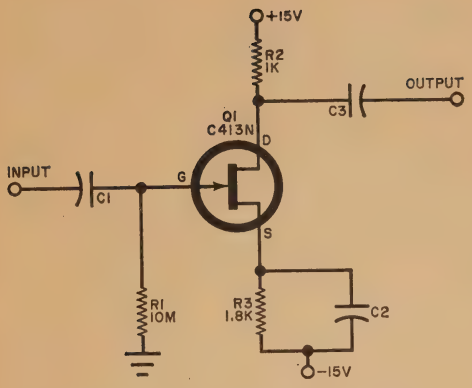


Fig. 3. This low-noise FET circuit can be used as instrument preamplifier.

a maximum noise level of only 1.2 μV, the circuit may be used as the first stage in high gain audio or transducer amplifiers, in signal tracers, in ac TVM's, and in similar types of test equipment.

The n-channel silicon FET is a type C413N. Resistor *R1*, *R2* and *R3* are half-watt resistors, while *C1*, *C2* and *C3* are low-voltage ceramic, plastic film, or electrolytic capacitors. The exact capacitor values used will depend upon desired circuit bandwidth as well as the source and load impedances. In general, however, *C1* will have a value of .01 μF, or less, while *C2* and *C3* may be electrolytics with values from 10 to 50 μF.

Circuit layout and lead dress are reasonably critical if the amplifier stage is wired on a board with other circuitry and, therefore, good audio wiring practice should be observed when assembling the amplifier. A well-filtered, regulated dc power supply should be used for optimum performance.

The Incredible Shrinking Calculator. A new standard one-chip MOS/LSI calculator logic circuit has been announced by Texas Instruments, Inc. (13500 North Central Expressway, Dallas, TX 75222). The TMS180-2NC, packaged in a 28-pin plastic dual-in-line case, consists of a 3520-bit read-only program memory, a 182-bit random-access memory, a decimal arithmetic logic unit, and control, timing and output decoders.

The TMS1802NC has been designed to operate with a minimum of external components. A simple switch matrix keyboard can be used with it because encoding and debouncing are performed on the chip. The display outputs are fully decoded, including inter-digit blanking and leading zero suppression, with only simple buffers needed to drive most commercially available numerical displays. It can be used with simple seven- or eight-segment LED or liquid-crystal optoelectronic displays.

With a performance equivalent to that provided by more than 6000 transistors in a discrete device design, TI's new "calculator on a chip" will be available for less than $20 each in large production quantities, although current sample prices are relatively high. Looking to the future, however, TI's new device could herald the age of low-cost pocket-sized electronic calculators for use by businessmen, students, hobbyists, and even housewives looking for bargains in their local supermarkets.

Device/Product News. Encouraged by the overwhelming acceptance of its "Super-Strip" breadboard element, AP Incorporated (72 Corwin Drive, Painesville, OH 44077) has introduced a sophisticated new breadboard system consisting of three "Super-Strip" elements mounted on an insulated base complete with an integral ground plane. Designated "Superboard I," the new unit is designed to accommodate LSI packages and, in addition, will accept any combination of DIP's, TO-5's and discrete components with lead diameters of up to 0.032 inches, or solid wire up to No. 20 gauge. Each single "Super-Strip" will accept up to eight standard 14-pin DIP's, plus a number of passive components.

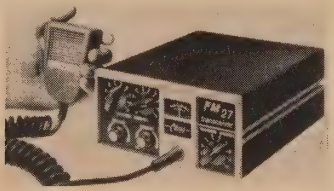
Two new inexpensive audio power amplifier Functional Circuit IC's, types MFC9020 and MFC6070, have been introduced by Motorola Semiconductor Products, Inc. (P. O. Box 20912, Phoenix, AZ 85036). Aimed at the consumer products market, the MFC9020 is rated at two watts output and is housed in an 8-pin stagger-lead plastic package with two heat dissipating "tabs," while the MFC6070 is a one-watt version supplied in a smaller 6-pin stagger-lead case. In both units, the input impedance is on the order of a megohm and only 200 mV input is required for full output, while the total harmonic distortion averages about 1% at rated output.

Motorola also has announced a new 512-bit field programmable read only memory (or ROM). Type MCM5003AL/5004AL, differs from other commercial units in that it can be tested by the user *before* programming. The pre-test feature was achieved by adding a ninth bit to the normal 64 eight-bit word organization, thus providing 64 extra elements. Several of these elements are used for factory tests, but over half are reserved for field tests by the user prior to final programming.

Signetics (811 East Arques Ave., Sunnyvale, CA 94086) has introduced a new 64-bit read-write random access memory (or RAM) organized as 16 words of 4 bits each for application in scratch pads and high-speed buffer memories. Designated type N8225B, the new unit is both DTL and TTL compatible. Inputs are one TTL load. Outputs sink 16 mA. The device also features "OR-tie" capability, while memory expansion is simplified by the addition of a chip select input lead. ◈

CLEGG FM TRANSCEIVER

A completely solid-state mobile tranceiver, the FM-27, has just been announced by *Clegg Division* of *International Signal & Conrtol Corp.* The principal feature of the unit is the new "Crystiplexer" tuner, a synthesizing system that allows any channel in the 2-meter band (146-147 MHz) to be monitored with crystal precision but without the need for additional crystals. To monitor any specific frequency within this band, the operator sets the two receiver controls to numbers corresponding to the



desired frequency. Receiver selectivity is rated at 70 dB of adjacent channel attenuation and sensitivity is rated at better than 0.35 μV for 20 dB quieting. The transmitter portion is a 10-channel solid-state unit with a power output of 20 to 25 watts r-f. Address: Clegg Div., International Signal & Control Corp., Box 338, Lititz RD #3, PA 17543.

CHEMTRONICS ROSIN-CORE SOLDER

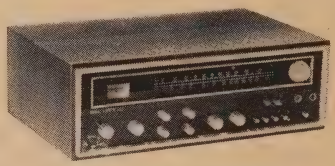
A new solder, formulated to meet the needs of the service technician, is available from *Chemtronics Inc.* It is a fast-flowing activated rosin-core solder said to have excellent wetting action. The size of the rosin core is predetermined to provide just the right amount of flux and is in direct ratio to the size of the solder strand. The rosin residue after soldering is noncorrosive, nonconductive, nonhygroscopic, and fungus resistant. The 60-40 tin-lead solder is available in both dispenser tube and one-pound bulk reel forms. Address: Chemtronics, Inc., 1260 Ralph Ave., Brooklyn, NY 11236.

JENSEN FLOOR-STANDING SPEAKER SYSTEM

Jensen Sound Laboratories' new Model 6 is a 4-way, four-speaker system in a floor-standing cabinet. The system's speaker complement includes a 15-in. woofer. 8-in. upper bass speaker, 5-in. mid-range speaker, and 1-in. dome tweeter. Crossover at 300, 1,000, and 4,000 Hz is accomplished with the aid of a dividing network that provides low phase shift. Two continuously variable balance controls permit precise adjustment of midrange and tweeter levels to accommodate individual room characteristics. Frequency range is 27-30,000 Hz; power handling capability is 75 watts; and impedance is 8 ohms. Address: Jensen Sound Laboratories, 5655 W. 73 St., Chicago, IL 60638.

2/4 CHANNEL RECEIVER BY SCOTT

H.H. Scott, Inc. is currently introducing its Model 443, an AM-FM 2/4 channel stereo "quadrant" receiver which features 15 watts per channel at 8 ohms with four channels driven or 35 watts at 8 ohms continuous (rms) output per channel, two pairs strapped for



conventional stereo operation. IHF power bandwidth is 25-20,000 Hz with harmonic distortion at rated output 0.5%. Hum and noise are said to be −75 dB at rated output. The reciever incorporates the company's "Modutron" circuit boards which can be replaced individually at a modest exchange cost. Other features include the special four-channel "quadrant" circuit which converts stereo to simulated four-channel reception, accommodation of encoded 4-2-4 channel systems, and a multiplex input/detector output which is adaptable to future four-channel FM multiplex. Address: H.H. Scott, Inc., 111 Powdermill Rd., Maynard, MA 01754.

CB UNIT FROM JOHNSON

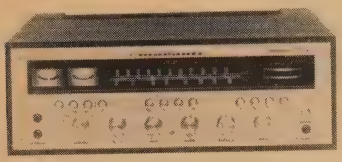
A new Citizens Band radio with controls designed for faster, easier operation has been announced by *E.F. Johnson Company* as its Messenger 121. The new unit has provisions

for up to 5 channels, selectable by pushbuttons. To permit faster channel switching, especially when going between widely separated channels. The need for the operator to take his eyes off the road is also eliminated. Pushbuttons also control the on/off and PA functions, separate from the volume and squelch so that these settings can be left undisturbed and always ready for use. The radio is supplied complete

with channel 11 crystals, microphone, and mobile mounting bracket. An accessory ac power supply is available for base station use. Address: E.F. Johnson Co., Waseca, MN 56093.

MARANTZ ADDS NEW RECEIVERS

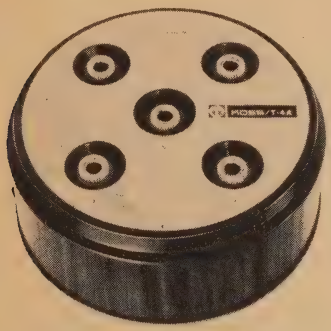
The *Marantz* Co. has added four completely new AM/stereo FM receivers to their line of



hi-fi components. Each features 4-channel-ready quadradial output and can be utlized as individual tuner/amplifier and power amplifier sections. Prices range from $199 to $499 for the new receivers. The $199 Model 2215 receiver is rated at 15 watts rms/channel. The $499 Model 2270 is considerably more sophisticated, sensitive, flexible, and powerful and is rated at 70 watts rms/channel. The two intermediate receivers are the $399 Model 2245 at 90 watts rms and the $299 Model 2230 rated at 60 watts rms. Address: Marantz Co., Inc., P.O. Box 99, Sun Valley, CA 91352.

KOSS 5-SET CONNECTOR BOX

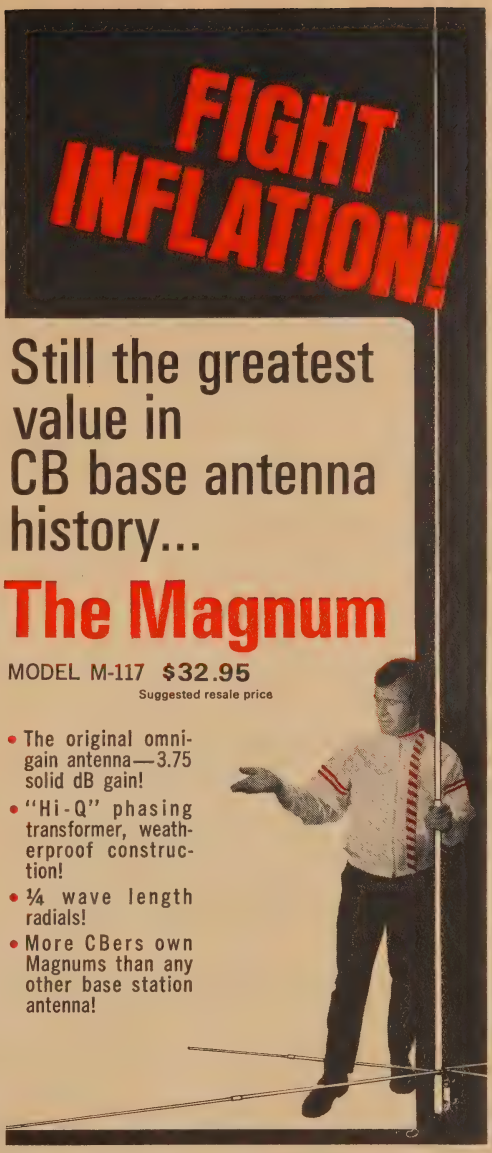
The Model T-4A connector box made by *Koss Electronics, Inc.*, is really a headphone station that provides private listening for up



to five individuals simultaneously. The Box accomodates standard headphone plugs. The Model T-4A is a trim 6-in. diameter round box on a walnut-like base. It has black trim and a spun-aluminum panel. Address: Koss Electronics, Inc., 4129 N. Port Washington Rd., Milwaukee, WI 53212.

MOODY OFFSET OPEN-END WRENCH SET

A 5-piece offset open-end miniature wrench set suitable for use in electronics work is now being marketed as the Model OE-5 by *Moody Machine Products Co., Inc.* The set is available in two sizes: the smaller is designed for electronic and hobby workers and contains 5/64",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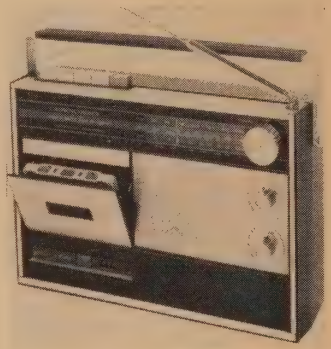
CROWN RECEIVER/CASSETTE RECORDER

An AM/FM receiver and cassette recorder which also provides shortwave reception has been introduced as the Model CRC-450FW by *Crown Radio Corp.* of Japan. It is available in traditional form with an external remote-control microphone for $79.95, and with built-in condenser microphone (Model CRC-455FW) for $84.95. The latter model also



provides recording via external remote-control microphone. Features common to both models are slide-rule tuning; switchable automatic level control; three-digit counter; direct recording from radio with simultaneous monitoring; 4" speaker; ac/dc operation with built-in selector for 110 and 220-volt ac supply; tone control; pushbutton transport controls; telescoping antenna; etc. Weight is 7.7 pounds. Address: Crown Radio Corp., 228 E. Harris Ave., So. San Francisco, CA 94080.

SPRAGUE LED'S FOR PROJECTS

Sprague Products Co. has introduced LED's and other gallium-arsenide semiconductors for experimenters and electronics hobbyists as well as for the replacement market. Available nationally through the company's distributors, the inventory includes popular styles of visible light sources, infra-red light sources, indicator lamps, alphanumeric readouts, photo-sensors, and opto-isolators. Address: Sprague Products Co., North Adams, MA 01247.

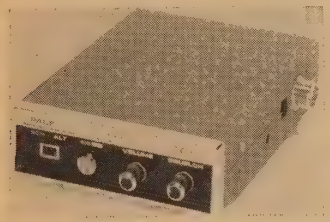
TDK TWO-HOUR CASSETTES

The C-120SD cassette, recently introduced by *TDK Electronics Corp.*, is said to be the first time a high-performance tape has been available in a cassette of extra-long playing time. The "Super Dynamic" cassette uses the

company's original gamma ferric (SD) oxide which offers frequency response capability from 30 to 20,000 Hz at the cassette speed of 1⅞ in./s, low noise levels, minimum distortion, and expanded dynamic range. Address: TDK Electronics Corp., 23-73 48th St., Long Island City, NY 11103.

CB MONITOR FROM PACE

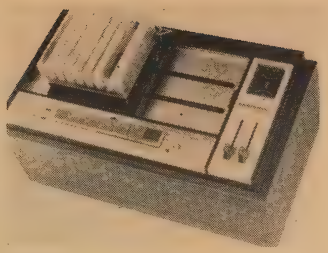
An emergency monitor for CB has been developed by *Pace* and is being marketed as the CB-9. This device enables a two-way radio



operator to maintain surveillance on Channel 9 or any alternate channel while he is engaging in two-way communications on another radio. The CB-9 is a full receiver with squelch and volume control. Sensitivity is ½ μV. It comes equipped for monitoring channel 9 with crystal supplied. There is also an alternate monitor switch on the front panel. Any other channel in the CB or Business band between 25-30 MHz may be monitored by adding a plug-in crystal for the appropriate frequency. Address: Pace Div., Pathcom Inc., 24049 S. Frampton Ave., Harbor City, CA 90710.

BENJAMIN 10-CASSETTE CHANGER

An advanced type of cassette changer with numerous automatic features, including the ability to play or record up to ten cassettes in sequence, is now being marketed by *Benjamin Electronic Sound Co.* Featuring automatic sensing of tape direction in fast-forward and rewind functions, automatic reverse, bypass of empty cassette compartments, and rejection of improperly inserted cassettes, the RAC-10 also offers wow and flutter of less than



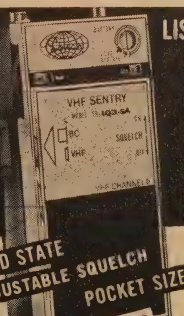
0.3% weighted, frequency response from 40-10,000 Hz ±1½ dB, and signal-to-noise ratio of 48 dB. The RAC-10 has a constant-speed hysteresis-synchronous motor as well as a synchronous cycling motor. It includes pause control and indicator lights to show when the record, programming, and side one/side two play functions are engaged. The circuit is all solid state and all mechanism controls are pushbutton, while the record level controls are slide types. Address: Benjamin Electronic Sound Co., Div. of Instrument Systems Corp., 40 Smith St., Farmingdale, NY 11735.

BOGEN COMPACT STEREO CENTER

A compact stereo system, developed by *Bogen Division*, is now being marketed as the BC360. Incorporating all the features and

performance specs of the company's BR360 AM/FM/stereo FM receiver, plus a deluxe BSR automatic turntable, with Pickering cartridge and diamond stylus in walnut. Address: Bogen Div., Lear Siegler, Inc., P.O. Box 500, Paramus, NJ 07652.

Sonar SENTRY VHF MONITOR RECEIVERS WITH ADJUSTABLE SQUELCH



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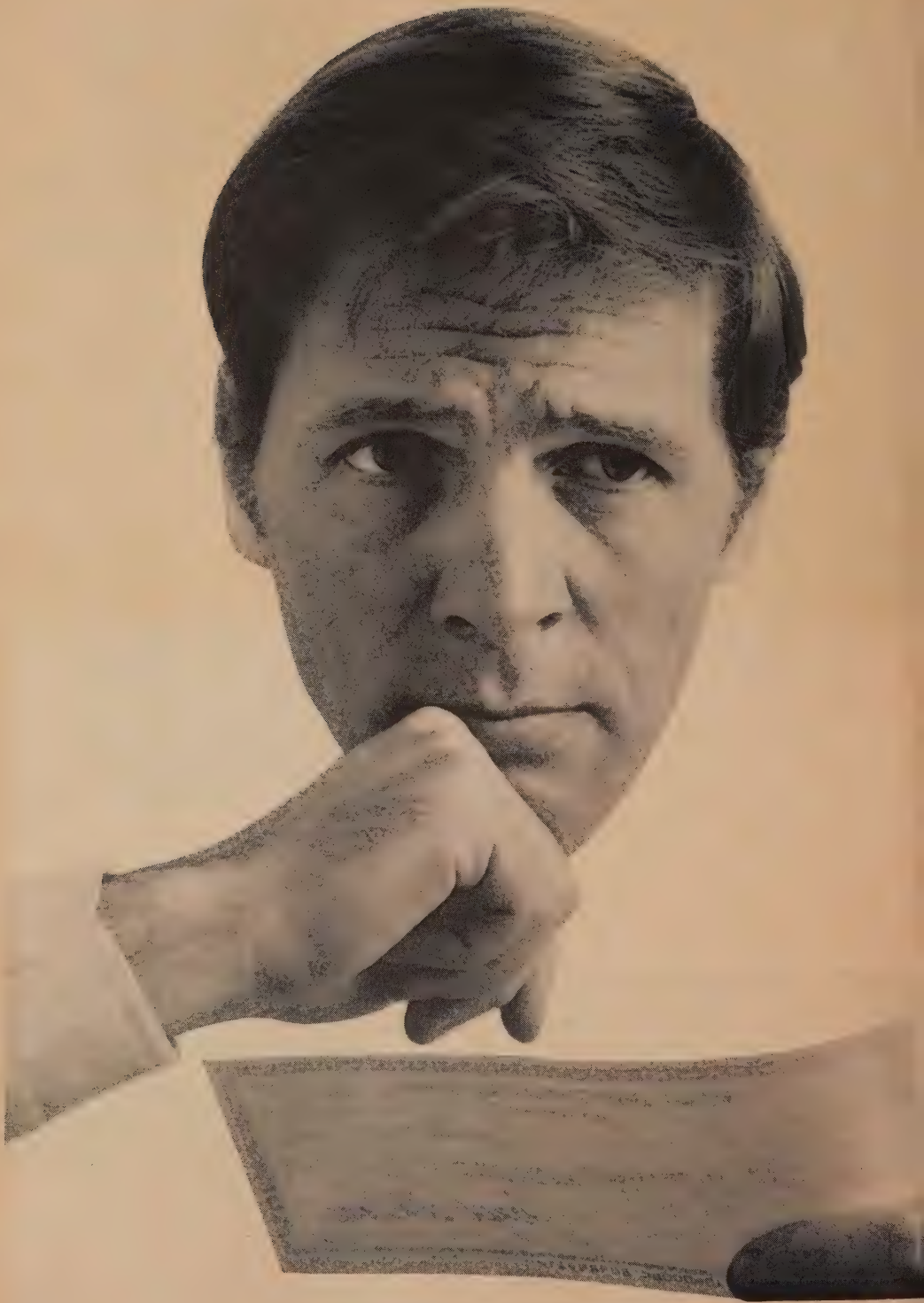

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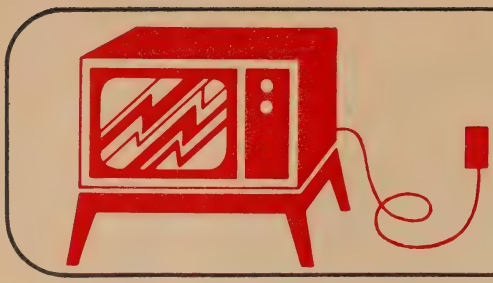

Television Scene

By Forest H. Belt

NEW COLOR SETS AND PROGRAMS

THE AMERICAN public has begun buying again—if tenuously. Makers of color-TV receivers had grown accustomed to a steadily climbing sales volume—until early last year, when the climb slowed to a halt and slid backward a little. But the show is on the road again, and prospects for 1972 look promising.

Color TV for 1972. Thirty or more brands, with around 150 different chassis in four or five times that many cabinet models, present a variety of choices. Screen sizes range from an imported 9-inch to a whopping square-cornered 25-inch. Some makers offer ultra-square 19-, 21-, and 25-inch picture tubes. Portables up to 16 inches sell well, but medium-screen console and table models are going better than expected. Here are details to watch for if you're shopping.

Detented uhf tuners are numerous. The FCC has ruled that 10% of each manufacturer's (or importer's) models must now tune uhf as easily as vhf. Later, even more, and eventually all of them must. Most detented uhf tuners don't really meet the letter of the rule, because the viewer has to set the tuner and add station numbers. Many tune only six or eight stations.

RCA, MGA, and Motorola have sets with 25 uhf positions. Sylvania and Magnavox have uhf search tuners that stop on active stations. That's not tuner equality, exactly, but it permits remote tuning of either band. The RCA and Motorola 25-channel uhf tuners operate remotely, too. Top-line Sylvania sets have an 11-button Varactor tuner; up to six of the buttons can be set for uhf.

Solid-state continues to grow as a design option. Motorola has a new no-tube Quasar chassis. RCA has three transistor chassis with SCR horizontal deflection. Zenith's new solid-state color chassis has the entire chroma section on integrated circuits. Sylvania continues the all-transistor design introduced last year. A half-dozen Japanese brands have transistor designs, the most notable new one being a neatly engineered MGA with 19-inch square-corner CRT.

Integrated circuits gain steadily. RCA has a chassis with five in it. Zenith uses five in the solid-state chassis. Surprisingly, only one Japanese brand made any significant stride in IC technology. Sanyo has a mostly IC chassis in prototype but not in production; you can't buy one till late this year, if then.

Thick-film integrated circuits came into the picture this year. They're easier to make for TV use than monolithic types. Reliability figures are not conclusive, but evaluations so far give thick-film IC's better performance history than ordinary transistors or IC's. The RCA idea of putting chip-formed IC's on special heat-sink ceramic substrates promises even greater reliability. Zenith slims down the horizontal sweep section of one chassis by confining it to one encapsulated thick-film module.

Prices are generally up, although more low-end models are available. You can buy small-screen color for well under $300, and some medium-size table sets for no more than that. The big 25-inchers run $600 or higher, depending on the furniture.

This merely thumbnails what you can expect of color TV this year. But if you've been waiting for some particular innovation, now's the time for you to shop. You can probably find it.

Television To Learn By. Commercial TV works hard to overcome its "wasteland"

image. Millions of dollars and endless efforts go into program pilots. Still, the fickle audience makes or breaks shows almost on a whim. Successful commercial television depends to this day on seeking the lowest common denominator among viewers.

Public television, the nighttime offshoot of educational TV, fares little better. Despite promises of higher quality, two factors persist: (a) money and talent to produce shows on that "higher" plane stay consistently meager, and (b) when something unique does happen, audiences almost studiously ignore it. Cynics conclude that television excellence wastes time and money.

In the schoolroom, countless miserably planned and executed TV lessons reinforce skeptical attitudes. Boards of education consistently withhold funds from instructional TV (ITV). "Wait till they get something that interests the kids, something they can learn from." That's a common excuse, and justified. If you find public or commercial TV boring, some afternoon turn the channel selector to your ITV station. You'll see what boring really is.

With the support of teachers, some outstanding school-TV programs this year are proving that boredom is unnecessary. Television, when used dynamically, stimulates classroom learning. Oddly enough, these model programs come from all three branches of television: commercial, public, and instructional.

A Saturday morning half-hour called "The Curiosity Shop" runs on the ABC television network. The show aims to help youngsters, ages 6 to 12, explore nature and machinery. NBC puts on "Take A Giant Step," a show ostensibly run by youngsters for youngsters; the focus seems to be personal values. CBS airs a Saturday morning young-people's version of the "You Are There" news-dramatized history series.

Public television (PTV) continues its now-perennial "Sesame Street." This series has been fabulously popular with preschoolers. Camera and other visual techniques, and a strong lineup of "host" characters, catch and hold the interest of older children as well. A new PTV series, "The Electric Company" adds more sophisticated attention-grabbers. The claimed target is 7-to-10-year old. But watch. This program has appeal for teens and young adults as well; although the

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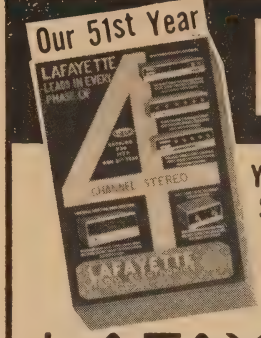

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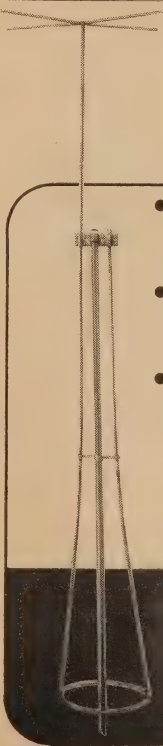

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avowed purpose might drive off a few viewers: to improve reading skills (a problem for millions of adults and a major cause of high-school dropouts).

So what about the bored youngster watching classroom TV? Two imaginative series are turning schoolchildren on this year. One is "Ripples," a social-awareness program. The old ITV notion was to find an expert and put him or her in front of a camera, with or without supportive visual aids. A "Ripples" segment or program is sort of an "encounter." The on-screen people are not teachers, but interesting people doing what they like best to do. They don't play to the cameras. The classroom viewer merely "looks in" on a happening.

Even more innovative is an art series called "Images & Things." There is no boring "how to paint" or "how to sculpt" instruction in these programs. Each one examines the visual (and aural, in some instances) impact of daily living. Form, color, design, motion, mixture—all alert the viewer to "art" that surrounds him.

This clever, basic concept is enhanced by camera and production gymnastics. The attention factor in upper-grade classrooms beats any previous ITV offering. Adults like the shows too. "Images & Things" could start a whole new viewpoint in television learning.

New-fangled school TV introduces other trends, too. *Good* ITV programs in color generate strong motivation for upgrading classroom reception facilities to color. Secondly, new and better programming converts holdouts; school-system sales rise steadily. Ultimately, the improvements are regenerative. Commercial, public, and instructional TV producers earmark more and more time and money for skillful, well-planned telecourses. There may be fewer new courses per year, but they will be better.

Bootleg Youth Radio. Traveling through a certain city not long ago I tuned across the AM dial on my car radio. I picked up a youthful-sounding announcer saying, "This is Radio Free ——town·" Then some noisy switching and bumping was followed by a 20-minute run of heavy acid rock. Then there were 10 minutes of youthful ranting against some unnamed annoyances

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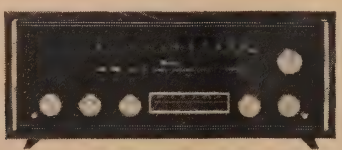

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CIRCLE NO. 23 ON READER SERVICE CARD

presumably caused by "the establishment."

The signal was weak, but it covered a couple square miles. There was no other station ident. I had stumbled across a recent fad—the illegal broadcasting station.

Kids set up little oscillators with a mike and broadcast around their neighborhoods. They play off-beat music for their friends, often on records some cooperating store loans them in return for mention "on the air." All too often, they get outside the law, intentionally or not. They have a too-long antenna, high power, and a lack of technical knowledge. Any of these can lead them to interfere with legitimate broadcasters, and put the kids afoul of Federal law. Sometimes, these experimenters exploit their medium with vocal vulgarity and lewd songs and verse. These are legal violations, too. Some almost comically fill the air with pseudo-political mouthings of philosophical ideologies they don't even understand.

Not every neighborhood operation is illegal. The fine line is drawn in Part 15 of the Federal Communications Commission (FCC) Rules and Regulations. If "transmitter" power is no greater than 100 milliwatts (0.1 watt), and the antenna no longer than 10 feet, there's no violation of the law unless profanity is used.

But distance is limited. The tenth-watt of power can only reach a block or less. So a few youngsters who don't know the legalities (or don't care) set about widening their audience. A longer antenna usually comes first, then extra power. One such illegal station ran 100 watts in the AM band. Another fed 60 watts of FM into a whip antenna.

Neither station was in any way legal. The illegitimate operators stood to incur penalties up to $10,000 and a year in prison. One FCC engineer says these operations are only occasional, but they're easy to track down. The risk is steep for a little "in" music or the "privilege" of broadcasting obscenities to an unknown and fragmentary audience. ◈

Editor's Note: Refer to our "News Highlights" column this month for a related development in the Citizens Band field. The crackdown continues on illegal operation in this area as well, although there's still much more enforcing to be done.

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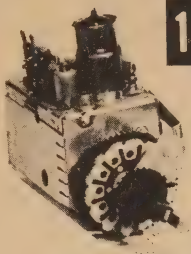

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CIRCLE NO. 32 ON READER SERVICE CARD

Surplus Scene

By Alexander W. Burawa, Associate Editor

TODAY'S SURPLUS DEALERS

MANY "new" electronics hobbyists have a distorted picture of what the surplus equipment dealers really are and the wares they have to offer. They have a stereotyped view of a dingy, dark shop crammed full of disorganized piles of junk.

While this may have been an accurate opinion in the years immediately following World War II when the military created a big surplus market, today's surplus dealers have done much to change the picture and improve their images. Most of them operate out of fairly modern warehouses and stores. But even those who occupy old stores have fixed up the premises for better eye appeal. The stores and warehouses—those of G&G Radio Supply Co. and Surplus Center, for examples—are well lighted and clean. The wares offered are neatly catalogued and easy to find, even in small local stores.

We have contacted a large number of surplus dealers to see what they are offering. Some of the dealers we will be mentioning in this column in future months do not even stock in their inventories items that can be classified as surplus. A few dealers stock mainly first-run, commercial quality items, buying in large quantity and passing the savings on to their customers. Most dealers, however, stock a happy medium of first-run and surplus gear. But they all give the customer very high quality merchandise at very low cost.

Once mainly local enterprises, many dealers are now big in the mail-order business, characterized by all the flavor and reliability of the big mail-order houses that cater to commercial interests. Illustrated catalogs and flyers are easy to obtain. Among the more famous catalogs are those put out by G&G Radio Supply Co., Surplus Center, BF Enterprises, Edmund Scientific, and, in Canada, Sabre Industries. Periodic flyers are available from such names as Poly-Paks and John Meshna, Jr. And an impressive monthly that combines the better elements of both catalog and flyer can be obtained from Herbach & Rademan, Inc.

Surplus Scene offerings include such diverse items as communications equipment, computer gear, lab-type test and measurement instruments, audio equipment and many new consumer items at wholesale prices. The component end of the business is usually limited to hard-to-find items such as computer-grade electrolytic capacitors, industrial transformers, and solid-state components.

Next month, we will be looking into the market of solid-state components—diodes, transistors, control devices, and IC's. We will be telling you where to get what. ◈

Informational catalogs and flyers of surplus dealers are easily obtained.

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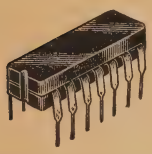

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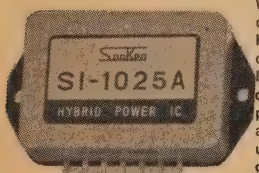

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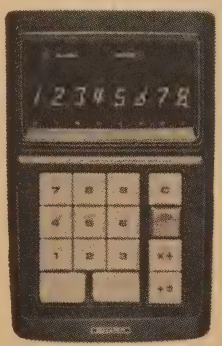

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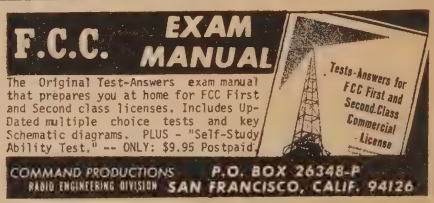
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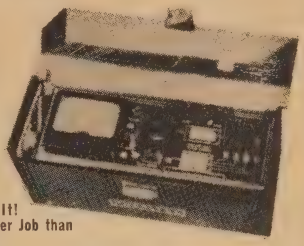

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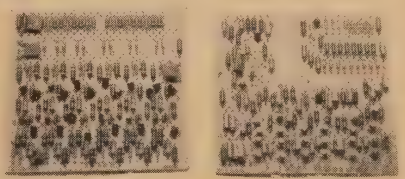

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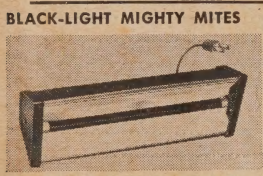

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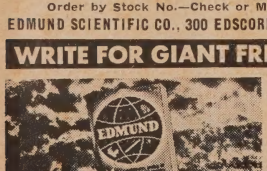

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121	122	123	124	125	126	127	128	129	130	131	132	133	134	135

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106	107	108	109	110				114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135

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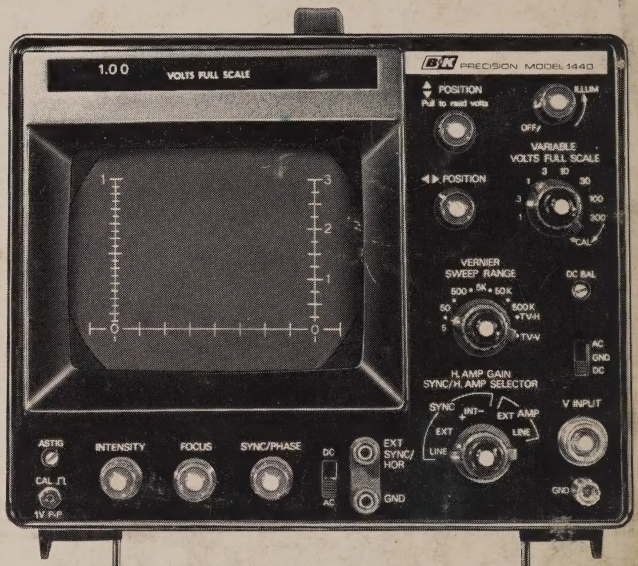

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About the Cali-Brain® System

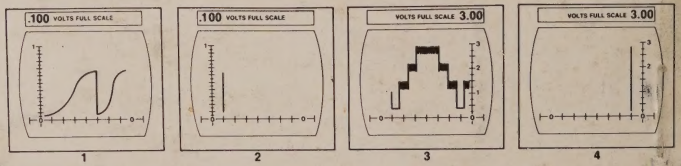
The CALI-BRAIN voltage measuring system increases your efficiency because it lets you examine any waveform and measure its peak-to-peak voltage without changing your test set-up. Now you can confirm the manufacturer's service data exactly – checking out typical waveforms and peak-to-peak voltage readings at various test points.

Cali-Brain® in Action

Use CALI-BRAIN when you want to measure peak-to-peak voltage of the waveform displayed on the scope screen. Here's what happens when the CALI-BRAIN switch is activated:

A. The horizontal sweep collapses and the waveform under examination appears as a straight vertical line.
B. A numerical indicator in the CRT bezel lights up to show the full scale voltage (including decimal point) corresponding to the Vertical Attenuator setting.
C. A graduated scale on the graticule overlay is illuminated on either side of the scope screen. The scale corresponds to the full scale voltage indicator in the bezel.
D. The vertical waveform line on the CRT moves to either side of the screen, to align itself with the illuminated scale.

The entire CALI-BRAIN action is automatic – and takes less than a second. After you have read waveform voltage, you deactivate CALI-BRAIN system with a single switch, and the waveform is again displayed. One probe and one test instrument – lets you concentrate on trouble shooting, not the test equipment!



To read peak-to-peak voltages utilizing Cali-Brain, note the full scale voltage reading in the bezel above the screen (fig. 1–.100 volts full scale) (fig. 3–3.00 volts full scale). Pull out the Cali-Brain knob and you will notice that the 1st waveform in fig. 2. reads .067 volts P-P and the second waveform in fig. 4. reads 2.95 volts P-P.

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